SPACE SHUTTLE REQUIREMENTS, OPERATIONS, AND FUTURE PLANS

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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CONTENTS

July 31, 1984:

Page

Hon. James M. Beggs, Administrator, National Aeronautics and Space Administration 3

Jesse Moore, Acting Associate Administrator for Space Flight, National Aeronautics and Space Administration, accompanied by L. Michael Weeks, Deputy Associate Administrator, Technical, NASA; Isaac T. Gillam IV, Assistant Associate Administrator, Customer Relations and Policy, NASA; and Charles R. Gunn, Director, Shuttle Operations, NASA 35

August 1, 1984:

Hon. Edward C. Aldridge, Jr., Under Secretary of the Air Force 70

Gerald D. Griffin, Director, Lyndon B. Johnson Space Center, accompanied by Glynn S. Lunney 127

Dr. William R. Lucas, Director, George C. Marshall Space Flight Center, accompanied by Robert E. Lindstrom 140

Richard G. Smith, Director, John F. Kennedy Space Center, accompanied by Tom Utsman 159

Dr. Donald P. Hearth, Director, Langley Research Center, accompanied by Paul Holloway 171

August 2, 1984:

William A. Anders, member, NASA Advisory Council, on behalf of Daniel J. Fink, Chairman, and John G. Stewart, member, Aerospace Safety Advisory Panel, on behalf of John C. Brizendine, Chairman 223

John Almond, vice president, corporate development, Telesat Canada 262

Michael T. Lyons, vice president, space segment engineering and operations, Satellite Business Systems 271

F. William Ziegler, executive consultant, Strategic Satellite Planning, Western Union Telegraph Co 280

Robert E. Pace, Jr., vice president, Microgravity Research Associates 288

R. Gilbert Moore, program development manager, space shuttle program, Morton Thiokol, Inc 293

Appendix: Letters to Chairman Harold L. Volkmer from R. Gilbert Moore, special projects manager, Morton Thiokol, Inc., and John G. Stewart of Aerospace Safety Advisory Panel 323

SPACE SHUTTLE REQUIREMENTS, OPERATIONS AND FUTURE PLANS

TUESDAY, JULY 31, 1984

House of Representatives,
Committee on Science and Technology,
Subcommittee on Space Science and Applications,
Washington, DC.

The subcommittee met, pursuant to call, at 9:40 a.m., in room 2325, Rayburn House Office Building, Hon. Harold L. Volkmer [chairman of the subcommittee], presiding.

Present: Representatives Volkmer, Nelson, Andrews, MacKay, Winn, Lujan, and Walker.

Mr. Andrews [presiding]. The committee will come to order.

Before we start, I'd like to ask unanimous consent that the TV cameras be allowed to stay in the hearing room and cover this hearing. Without objection, it will be so ordered.

Mr. Volkmer, our chairman, found that he was going to be unavoidably late this morning. He will be here, but he is running late from a flight, so he asked me to assume the chair to start our hearing today. He's forwarded an opening statement which will be submitted, without objection, to appear in the hearing record immediately following my remarks.

I have long been a fan of NASA and the space shuttle program. I'm especially proud of the shuttle's accomplishments because many of my constituents who work at the Johnson Space Center in Houston have played a major role in helping the shuttle achieve its great success.

The hearings that we are beginning today are attempting to ensure that the shuttle's record of success will continue in the coming years. To achieve the degree of growth projected for the shuttle program and to achieve that growth in a manner that is consistent with the present stated goal of encouraging private sector space initiatives, it is clear that major changes will have to be made in the way space shuttle missions are planned, formulated and executed. The intent of these hearings is to address the operational issues that must be solved to ensure that the space shuttle will indeed be able to operate at high, steady state launch rates in an economical manner with continuing excellent safety records.

Today we will hear from James Beggs, the NASA Administrator, and a panel of NASA officials headed by Jesse Moore, the recently announced Associate Administrator for Space Flight.

Mr. Beggs, I'd like to thank you for being once again with us here today. And what I would first like before we hear your opening statement is to recognize Mr. Lujan, the senior Republican member of our subcommittee, for his opening statement.

Mr. LUJAN. Thank you very much, Mr. Chairman.

This hearing is an important milestone in the space shuttle program. And although the space shuttle is no longer strictly an R&D program, it also is not yet fully operational. So as we look at the requirements for the next phase of the shuttle program, we will first need the knowledge of what the present status is, both the problems and the successes.

In addition, a successful transition will require a consensus at—as to what we want the future to be for the space shuttle.

Many of our policy decisions will be affected by whether we anticipate that the shuttle operations will remain within the Federal Government or whether the shuttle operations will be transferred at some point to the private sector. For example, if the shuttle operations are to remain with the Government, then the appropriate policy would be the true marginal cost. However, if the shuttle operations are to be transferred to the private sector, then we should design our pricing policies toward full cost recovery as soon as possible.

If we're going to go with a commercial system and full cost recovery, there are additional implications as far as the relative priorities with the shuttle program. A fully commercial shuttle would imply that the highest priorities should be minimal cost and maximum dependability.

If we're going to go with a Government-operated system, then the flexibility of the system should be the top priority. In this kind of situation, increasing the flight rate is not as important as getting the most value out of each flight for the taxpayers. I would like to note that the manifest through the 1990's shows that at least two-thirds and, in many cases, over three-quarters of the shuttle pay flights will be Government users as opposed to commercial users. Since this means that the Government will be the major user, it doesn't make sense necessarily to have a commercially operated shuttle.

Commercial use of the shuttle is currently dominated by communications satellites. This particular use is simply an alternative form of transportation to the ELV's. The potential for the development of shuttle-unique commercial application is the real strength of the space shuttle and should be given a top priority in shuttle marketing efforts. This, too, has strong implications for shuttle policies in pricing decisions.

NASA set a fair pricing policy in 1977 to recover the operating cost of the shuttle system, including the hardware, the launch flight operations, and the overhead. When it was discovered that the costs were higher than originally estimated, a new pricing policy was developed—seemingly to justify lower prices. It is important that we review this policy in conjunction with developing a consensus about what we want for the future of the space shuttle.

So, Mr. Chairman, I look forward to the series of hearings this week as a major step in resolving some of the issues and formulating policies.

And, Mr. Beggs, welcome to the committee once again, and thank you very much, Mr. Chairman.

Mr. **Andrews**. Certainly.

Mr. Winn, did you have an opening statement?

Mr. **Winn**. No, thank you, Mr. Chairman.

Mr. **Andrews**. Mr. Beggs, the floor again is yours, and please feel free to read your statement or just summarize its contents.

[The opening statement of Mr. Volkmer follows:]

Opening Statement of Hon. Harold L. Volkmer (D-MO) on Space Shuttle Requirements, Operations, and Future Plans, July 31, 1984

Today begins the first of three days of hearings that the Subcommittee will hold on the subject of Space Shuttle requirements, operations, and future plans.

The primary purpose of these hearings is to review the current status, evolving trends and philosophies, and future plans for the operational management and utilization of the Space Transportation System. During the next three days we will hear testimony from representatives of NASA, DOD, NASA advisory panels, and the civil user community.

Since its first research and development flight three years ago, the Space Shuttle has demonstrated its flexibility, reliability, and an ever-growing performance capability. However, the system has also demonstrated that during the current buildup period we can expect to see some growing pains.

As we look to the future, it is clear that major improvements are going to have to be made in the manner in which missions are planned, formulated, and executed, and the speed with which flight equipment can be readied for their next use. These improvements are essential if the program is to be able to achieve the steadystate operations envisioned for the late 1980s and thereafter.

At the same time, program managers will have to be vigilant to ensure that initiatives to reduce time lines and operating costs do not jeopardize the excellent quality control levels and flight safety records that have characterized the Space Shuttle program.

STATEMENT OF HON. JAMES M. BEGGS, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. **Beggs**. Thank you, Mr. Chairman. I have a fairly short statement that I'd like to read.

Mr. Chairman and members of the committee, I appreciate the opportunity to testify before you on the subject of shuttle operations and to provide my views regarding STS organizational and ownership issues.

The space shuttle has demonstrated that it is the most reliable space transportation vehicle ever built. I believe it has the capability to meet all presently projected foreign, commercial, DOD, and NASA requirements for years to come and provides this Nation an outstanding capability for exploring commercial opportunities in space.

One of our major objectives is to establish the framework and policies upon which to base the organization and management structure for future STS operations. To accomplish this, I intend to establish a shuttle operations strategic planning group to undertake a comprehensive assessment of options for future operation of the space transportation system. We are also beginning a review of our shuttle policies to make them current and ensure that they will help us progress toward our goals.

The strategic planning group will address your request for preliminary timetable for completion of activities to fence all shuttle operating budgets, facilities and personnel, along with a rationale for timing of each milestone. It will also address organizational design and identify options that would allow segregation of shuttle operations within NASA, possibly preparatory to divestiture and formation within a government or commercial corporation or other institutional setting. My own feeling is that there are a number of developmental efforts that we must continue that may take us through about 1988, but that we should be able to come back to the subcommittee late in 1986 with possible options to turn the shuttle operations over to a quasi-government corporation, or possibly transfer it to the private sector.

Our planning during the next few years focuses on bringing the STS to operational maturity. This includes essential modifications to the orbiter fleet; improved life and operating margins on the main engines, particularly the high-pressure pumps; production buildup and producibility improvements on the external tank and the solid rocket booster; and ensuring that an improved operational capability is in place in the next 3 years. We also must strengthen our partnership with DOD and help them prepare for manned space operations at Vandenberg Air Force Base and the Shuttle Operations and Planning Center at Colorado Springs; and also providing increasingly efficient and customer friendly operations for shuttle and spacelab users. Jesse Moore, the recently appointed Associate Administrator for Space Flight, and the NASA Center Directors, who will be appearing before the subcommittee in the next 2 days, will provide you with more details on our activities in each of these areas.

This concludes my prepared remarks, Mr. Chairman. I'll be pleased to respond to questions.

[The prepared statement of Mr. Beggs follows:]

STATEMENT OF MR. JAMES M. BEGGS, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and Members of the Subcommittee: I appreciate the opportunity to testify before you on the subject of Shuttle Operations and to provide my views regarding STS organizational and ownership issues.

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Operations and Planning Center at Colorado Springs; and providing increasingly efficient and customer friendly operations for Shuttle and Spacelab users. Jesse Moore, the recently appointed Associate Administrator for Space Flight and the NASA Center Directors, who will be appearing before the Subcommittee the next two days, will provide you with more details on our activities in each of these areas.

This concludes my prepared remarks. I will be happy to answer your questions.

Mr. ANDREWS. Thank you, Mr. Beggs.

I guess, initially, a question about NASA and its overall planning concept. Up until this point, in terms of long-range planning for the shuttle, how structurally has NASA gone about its review? Has it been ad hoc? Has it been by formalized committee? Is this a new initiative?

Mr. BEGGS. No. As you know, Mr. Chairman, NASA has a well established planning procedure, both for the short range and the long range. We try to look at 5 years and prepare both a financial plan and operating plan for the coming 5 years.

It—the shuttle—represents a very complex and perhaps unique system, as far as NASA is concerned. We've never had anything quite like this in our history. To be sure, we had had in the past some systems which became operational and were turned over to others, but they were—there was always a place where we could find a home for those activities. In the case of weather satellites, it was clear that the agencies, the Department of Commerce, were well established and capable. In the case of communications satellites, there was an industry there, and it was clear that we should, at some time, work out a means by which that system could be put into a commercial setting.

But in the case of the shuttle, we have a major transportation system that is somewhat unique in that it is the prime means that this Nation intends to use to get into space. It has no clear home, either in the Government or in the private sector. As was pointed out by Mr. Lujan, at least for the foreseeable future, something over 60 to 70 percent of it will be—of capacity will be used by Government customers and, therefore, one has to work out some entirely new arrangements, I believe, in order to find the right place and the right operating procedures for the future of that system.

But it is an extremely important issue and NASA recognizes that. We've been trying to come to grips with that and, as you know, over the past 3 years, we have been attempting to consolidate and aggregate our support service activities in such a way that we are in a position to transfer the system or to operate the system in the future in the most efficient way.

Mr. ANDREWS. Do you think it is realistic, based on where the shuttle program is now, to conclude that we will be able to have 24 shuttle flights a year by the late 1980's?

Mr. BEGGS. Yes, sir, I believe that is a realistic projection. The crystal ball is a little bit cloudy into the late 1980's period for two reasons, one is that the commercial requirement is not as clearly outlined today as indeed it was just a few years ago, and probably will be again clear in another few years. The reason for that is that there is currently an overcapacity of communications transponders on orbit. My expectation is that that will be absorbed by the market in the relatively near future, but right now, there is some uncertainty in the marketplace and, as a consequence, companies have been holding back from making new commitments. So that makes our manifest a little bit uncertain at the present time—or more uncertain than it has been.

The other uncertainty is the DOD and what they intend to do with a backup capability for their launch needs in the future. Depending on how that develops and how much of their various payloads they take off the shuttle and fly on expendable vehicles, it will directly affect our manifest.

Mr. ANDREWS. Well, how in the negative——

Mr. BEGGS. As far as the capability is concerned, Mr. Chairman, we are putting in place a capability to fly up to a 24 per year flight rate. I think that that's in the cards to do.

Mr. ANDREWS. What kind of, in trying to look—project ahead, what kind of major organizational structural changes do you think will be needed to be made at NASA to get to that goal?

Mr. BEGGS. I think we've got to continue our consolidation activities in the support services that we have initiated already and, as you know, we are in the process with a couple more of those kinds of contractual activities so as to improve our efficiency of operations and to position ourselves to operate the system flexibly in whatever manner, or whatever institutional setting that it's decided to to put the shuttle in.

Second, I think we've got to continue to drive the costs of the consumable items down on the system, and that means to continue our productivity improvements on the external tank, to continue our improvements of the main engine and make that a more durable machine than we have today so that we can fly a number of flights without overhaul or significant maintenance on the engines. And the SRB's must be driven down on the learning curve we're on to a—to a lower cost. We're in the process of doing all those things, and I think they are achievable as well.

Beyond that, we've to draw the plan that I mentioned in my statement to proceed with the kind of thing that this committee asked us to do, and that is to see whether we can put a fence around the shuttle in the sense of knowing clearly what our operating costs are going to be in the late 1980's so we can——

Mr. ANDREWS. Let me interrupt you for——

Mr. BEGGS [continuing]. Both price it properly and ensure that, when we get ready to turn it over, if we turn it over—when we get ready to do that—that the organization that takes it over has a clear cost baseline.

Mr. ANDREWS. Let me ask you to maybe editorialize a little bit. The NASA Advisory Committee and several former NASA Administrators have all proposed a—the fencing concept. What's your view? Will it work, and can it work?

Mr. BEGGS. I think it will work. I think it will work once we get our current series of technical problems well in hand. We still have several technical problems with the shuttle. I think while we would have been very happy to have those behind us at this time period, I think it's not unusual in a system of this complexity that we—we still have a laundry list of several technical problems which have to be solved, and I mentioned those in my response to your last question. But to repeat, they include the main engine and the productivity we need on the SRB and the—and the shuttle—or the external tank, the shuttle external tank.

And we still have to achieve the full payload capability that we promised to our customers, most particularly the DOD, and that involves getting a lightweight case for the SRB's and to do further weight improvement on some of the other systems in the shuttle.

We probably are also going to have to, at some time, replace the main processing, main computer processors, on the shuttle, simply because the current machines we are using, which have had some well advertised problems connected with them—but the main problem with them is they are now 15-year-old technology and, as you know, the computer field moves very rapidly, and we will increasingly find it difficult to buy hardware to maintain those machines. So probably we are going to have to replace those with a more capable machine. That's really not a major technical problem, but it is a problem that should be solved before we reach full operational capability.

Mr. ANDREWS. Mr. Beggs, I have a few more questions of you, but I'm going to pass my turn now and let some of the other members—at this point, I would recognize Mr. Lujan.

Mr. LUJAN. Thank you, Mr. Chairman.

This whole pricing policy is very fuzzy. It seems like, to me, we have all these competing interests, and maybe we ought to visit a little bit about that, Mr. Beggs.

We have on the one hand—well, I suppose, basically, we want to continue the research portion of the shuttle. In order to do that, we can't do without the payloads of the Department of Defense. That will help bear the cost of doing it. They, on the other hand, want to go into ELV's, and that poses a little bit of a—well, a substantial problem, I should say—although, at the present time, they say that it would be for a backup, and that makes a lot of sense, but we all know that once you look at—at the costs associated with the shuttle or with an ELV, they are going to, it seems to me, push on for more ELV's. We have, of course, the competition with the Ariane, and we want to encourage the private companies in—in their whole launching effort.

Let's—let's take the DOD question first. How long would it be before they—before DOD could be ready to launch on their own, just completely ignoring the shuttle if they chose to?

Mr. BEGGS. Well, my personal view on that is that it is probably a little later than they think it is. They are projecting late 1988, but I think it's probably going to be 1989 as a more probable date. But, you know, by the turn of the decade, they will be ready to operate on their own if they continue to push the initiative that Secretary Aldridge has put forward. That is of concern, because, first of all, the shuttle was designed—the initial design of the shuttle was sized and the capability was—was specifically designed for the DOD. Not that it was not also capable of handling foreign, commercial and other NASA payloads, it was. But it was very specifically done to attract that particular market. And it has been in the plan from the beginning that the DOD would use upward of a third of the capacity.

So if we lose either all or a significant percentage of that market, it has a very severe impact on the shuttle costs for the simple reason that the system, any system of this type—but this sytem—but this system included is very sensitive to flight rate.

Mr. LUJAN. You're not——

Mr. BEGGS. Always, you've got a big fixed-base cost. You've got a large standing army that's—that's down there that's going to be there whether you fly a lot or a little. You have the facilities in place in order to handle the higher flight rate, and all of those result in a very large overhead or fixed costs which must be absorbed, so that, to the degree you can fly more, you can reduce the costs per flight. And the loss of a significant portion of the DOD market would have a very severe impact.

Mr. LUJAN. The traffic—your traffic model through 1990 shows 1984 them using 25 percent, 1985 just 10 percent, as a matter of fact and nowhere does it seem like they are using the third of the——

Mr. BEGGS. They haven't. They are not flying as much as we and they anticipated. I don't think that's so disturbing in the near term because, in the near term, what happened is that they did tend to overbook somewhat because they wanted to assure themselves of the capability.

But in the long term, they still are projecting a very significant number of flights on the Shuttle, eventually upwards of six to eight a year, and that would be the——

Mr. LUJAN. Third.

Mr. BEGGS [continuing]. Third that I was mentioning.

Mr. LUJAN. That——

Mr. BEGGS. But in the near term, they've had a lot of problems, and as a consequence, they have demanifested or taken off the shuttle a number of flights which were projected. As a matter of fact, we have yet to fly the first full DOD flight, and that's through no fault of the shuttle. It is a problem, a well advertised problem, on the upper stage, the IUS, which should be corrected towards the end of this year. So we should start to fly.

But the concern is that—at least my concern is that if they develop a backup capability in the form of an ELV in which they can put the—the payloads that they intend to fly, it's a bit of a catch 22, because the shuttle price is fixed, and per force has to be fixed in any given year, because you have to allow your total customer base to know in advance. Most of these bookings take place 3 or 4 years in advance of the flight. You have to let them know what the costs are going to be in that time period.

Mr. LUJAN. What's——

Mr. BEGGS. So once you get to that time period, if they've got an expendable backup, what they will do in any given year is take a look at that and say, A, if we fly the ELV, let's say, four times instead of two, we can literally just cut the high overhead on that ELV in half——

Mr. LUJAN. Yeah.

Mr. BEGGS. So we can save a lot of money. So they take them off the shuttle. They say, well, will the shuttle suffer? Of course, the shuttle will suffer. Will they charge us more money? No, they still get the same cost per flight.

Mr. LUJAN. What—if they're not going to be ready, as you say, until around the turn of the century, would the private launchers serve as a good backup? Assuming that, for some reason or other, there was a shuttle delay and they needed to get——

Mr. BEGGS. Yeah.

Mr. LUJAN [continuing]. Something up.

Mr. BEGGS. I can't gainsay the need of the DOD to have "an assured launch capability" and of using a backup. The issue of assured launch capability can be debated forever. There really is no such thing as an assured launch capability because launch facilities are built on the coast—and they pretty much have to be for safety reasons in peacetime—they are built on the coast. They are big, they are exposed. All it would really take is a—is a submarine surfacing off the coast and lobbing a missile at them, when—even a very small missile, when there is a booster on the pad, and Katie bar the door, that's all she wrote.

Mr. LUJAN. No, but I mean about the capability with the private launchers. Could that be adequate backup?

Mr. BEGGS. The private launchers really don't serve the need they want. What they are after is very heavy lift, or heavy lift in the current context, so they need a very large booster. They need something in the class of a Titan, Titan/Centaur capability—not the current Titan—an upgraded Titan, because they are talking about very heavy lift.

The obvious alternative or the obvious candidate for that, from our point of view, from the NASA point of view, is a shuttle derived vehicle. We could take the SRB's and make a very capable launch system for them which would give them an expendable backup, and it would have the virtue of using the same launch facilities as you use for the shuttle so that we could spread the overhead of the launch. And, of course, to the extent that they bought those off our production line of the SRB's, it would contribute to the lowering of the costs of our SRB procurement as well. So that has significant advantages.

Moreover, it has a large advantage for them, because in the long run, they are going to need even larger boosters, even more lift, and the SRB technology, which is the most modern technology currently available, would allow them to develop boosters which could launch upwards of a quarter of a million pounds in the low earth orbit. So, in the long run, it has a lot of advantages. However, as I see it now, that will not get a good hearing.

Mr. LUJAN. You spoke of the two problems—the engines, which is well advertised, that particular problem. The SRB's, what are talking about with problems, just production schedule?

Mr. BEGGS. No. It's primarily cost there, although we still have a development program going on for lightweight cases to increase the capability of the system. The lightweight cases are coming along now quite well. We were a little worried on schedule there 4 or 5 months ago, but, in the last few months, we seem to have recovered our schedule position pretty well. And I think we will be in a position to fly the lightweight case SRB's in the late 1985 or early 1986 time period, which is the schedule that we were aiming at.

Mr. LUJAN. One final question. How about just the next generation shuttle?

Mr. BEGGS. My view on that is—and we, of course, are doing what NASA always does, and that is pursuing the technology in our research laboratories, looking forward to the day when we will upgrade or design a new system.

This system was designed, as you all know, for 100 flights for each of the orbiters. We have a—with the 4 orbiters we are buying, we have a 400-flight capability. If we buy a fifth. we'll have 500 flights. That will carry us well into the 21st century. And——

Mr. LUJAN. That's if you become operational. But if you're still in the R&D mode, then we look at a next generation.

Mr. BEGGS. Well, this system's coming along well enough that if the country continues to pursue it on the basis that we have now laid down the plan, there's no question in my mind that we can operate routinely. I use that word with some hesitation because routine space flight is never routine. But we can operate more or less routinely through the next couple decades with the system.

However, there will come a day, and that's probably—that day's probably sometime in the—in the early 1990's—when we will want to design an upgraded system.

Mr. LUJAN. I was——

Mr. BEGGS. But because the technology moves, then you'd want to take advantage of it.

Mr. LUJAN. I was thinking mainly of if in my lifetime I will see one take off and return to Kirtland Air Force, for example.

Mr. BEGGS. Yeah, I think we'll live to see that.

Mr. LUJAN. Thank you, Mr. Chairman.

Mr. ANDREWS. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

Mr. Beggs, an old saying around Washington, when in doubt, appoint a blue-ribbon commission. Is that what the STS strategic planning group is going to be?

Mr. BEGGS. No.

Mr. WINN. For fulfillment of a doubt?

Mr. BEGGS. I subscribe to your comment. That's true.

No, that isn't our intent. Our intent is to really—draw a plan that we can pursue for the next 5 years to get us to the point where we can operate this thing in a mode that will provide for servicing all of our customer base, both commercial, foreign, NASA payloads, and DOD payloads.

And necessarily, I think that says that we've got to get it at least fenced off from the normal NASA R&D for several reasons. If we keep it involved with the NASA program, NASA folk are very good and their heart is in the right place, but they're—we are primarily engineers and scientists. So, to the extent we have it in our normal procedure, we'll keep improving it. And we shouldn't do that with this. At some point, we ought to cut it loose.

Second, the customers have to be serviced adequately by an organization that's devoted to their needs, and I don't think that NASA is in position in the long run to really do that. One of the problems with the DOD, quite frankly, is that the DOD has an agreement with us which is no more binding than an agreement between two Government agencies—that is, it is based on a memorandum of understanding or agreement, and that is not a contract which they can enforce. To be sure, they can always escalate it into the Oval Office, but that is something that sometimes you can get the President's attention and sometimes you can't. So they worry about that. They'd rather have a binding contract, and they can't write a binding contract with NASA, so it would be desirable, I think, to have an institutional setup that would provide them the means of enforcing a contract.

Now that's the sort of the ground or the baseline from which this group will start. I've asked Ed Smiley, who is an old NASA hand and who's now working for RCA, to head that group so that we get a guy who's had some experience in business as well as experience in the Agency. He knows both sides. And he will head the group, and the group will be made up of both NASA people and outsiders. And our intent is really to get to a hard plan that we can set a way to proceed from here to there.

Mr. WINN. Well, I'm glad to hear that because I just didn't—I was concerned, as I have been down through the last several separate commissions that have been appointed, whatever the reason might be, that it was usually NASA personnel and contractor personnel talking to each other, guys that have been working on these things for years together, and just sitting at a different table looking into whatever that problem might be that they were investigating.

So I urge you to stay on this line on the strategic planning group with the idea of having some—certainly some NASA personnel, but some outside people that might challenge some of the NASA ideas from time to time. Not that NASA doesn't challenge itself from time to time. I am aware of that.

I just wondered, on a little different line of questioning, if we now have the capacity, as far as the facilities are concerned, for the 24-flight rate that you talked about?

Mr. BEGGS. Well, we're demonstrating right now that we can turn our orbiters around in 2 months and—with the facilities that we have. Now we're up to three on line, although we're really not in a posture of operating on a continuing basis, but we soon will be, and we'll take delivery of the fourth sometime toward the spring of next year. If we can continue to operate on that 2-month turnaround, then we're already to a capability to operate 24 a year.

Nevertheless, we have some things that need to be done in order to make that flight rate a sure thing. We still have to lay in a lot of spares. Spares continue to be a problem with us, and we are setting about doing that. We must continue to improve on our servicing capabilities down at the Cape so that we can solve any unforeseen problems that come up as you start to fly at higher rates, and I'm sure we'll run into some of those as we start to increase the flight rate.

This coming year will be a real test case for us, because we're going to try to fly 11 times in the coming year. We've had well advertised problems this year. They have been mostly problems that are not of our creation. That is, they relate to upper stage problems which are bought on the commercial market. And—but they also relate to upper stage problems which are within the government, like the IUS. But we have had those problems, and they have impacted us severely.

We've also had the situation on this last launch which made everybody a member of the 4 seconds and counting club, and that is something that we would not like to repeat, obviously, and we're going to work very hard to make sure that we don't repeat that. But, as I said earlier, we're still learning about this system, and I don't think the committee or the Congress should be overly critical of that fact, because if this were a completely commercial program where you were flying a commercial transport of this complexity, you would clearly not expect after 11 flights to have all your technical problems worked out. Quite the contrary. On a commercial transport, which is a much simpler system by far than this one, before you introduce it to routine service, routine commercial service, you would have flown it several hundred times and corrected a lot of technical problems. We are correcting them as we go along and we'll continue to do that.

But to getting back to your question, the key to the answer to that question is how well we do this coming year. If we can get that 11-flight schedule under our belt through the end of the next year, then I think we'll have a lot of confidence that we can go on up to 24——

Mr. WINN. Do you foresee——

Mr. BEGGS [continuing]. Without running into severe problems.

Mr. WINN. Do you foresee any additional costs involved to enable you to reach the 24-flight capacity?

Mr. BEGGS. The one remaining issue that would have a severe cost impact is the purchase of a fifth orbiter, and we are examining that in—continuing to examine that. And the—if we do up to fifth orbiter, it probably is going to cost a billion and a half or so, maybe more. But it is in that vicinity, and that's the only really severe cost impact I know of.

We do have, as I say, the problems that I laid out, but they're well budgeted, and I think we'll be able to solve the various technical problems we have within the budget projections we've made.

Mr. WINN. Well, as you know, I've long been a supporter of the fifth orbiter, and you just pointed out we might have come within 4 seconds of blowing up one of our four one way or the other.

Mr. BEGGS. No. No. I don't want to leave that impression.

Mr. WINN. OK. That's my impression.

Mr. BEGGS. No. I think this is very important, Mr. Winn, and I think I ought to make a statement on this, because there were some fairly wild reports at the time, which, incidentally, I am happy to see have largely been corrected in the media.

The system worked exactly as it was intended to work. And, we demonstrated a completely fail-safe system, and I think we can all take pride in that, that we can count down to 4 seconds—indeed, we can probably count down a couple more seconds—and still fail safe.

Mr. WINN. Let's don't try it.

Mr. BEGGS. I don't want to do it. I agree. I don't want to do it.

But the fact that we can do that, I think, is a demonstration of how well this system was designed, and the fact that we have a very, very effective system that will allow us to operate very safely in the future. And while we—well, what we would like to do is get in the habit of launching on schedule and not having these delays. It also gives me a good warm feeling in the pit of my stomach that we can—that the system will work that well.

Mr. WINN. One more question, Mr. Chairman, if I may. I'd like to ask Mr. Beggs what's been their experience to date of the STS total system overhaul, the maintenance and the replacement costs, after each flight?

Mr. BEGGS. It is better than we anticipated on, I would say, about 80 percent of the subsystems aboard the shuttle. It is worse than we anticipated on some of the major ones which have been well advertised. The main engine clearly does not have the time between overhauls that we need and—and estimated in the beginning, in particular the high-speed rotating machinery, the turbo pumps, are not giving us the life that we need and we're having to change out.

I want to emphasize here this is not a safety of flight issue. When we fly, we are sure that we have hardware which will operate properly. But it is a problem on cost, as your question observes, and it is of concern.

We also have had some well advertised problems on the APU, which, incidentally, is a little bit of a misnomer. It is not an auxillary power unit, it is the prime power when we're coming back in. So it's extremely important, and that has not exhibited the time between repair and overhaul that we need. And we have gone to work on both those problems. And I think within—well, in the case of the APU, within a year and a half or two, we will have an APU which will give us the projected mean time between overhauls. And, the main engine's going to take a little longer. I would say within 3 years, maybe 4, we will be at the point where we can anticipate that it will have the time and the life that we require.

We've also had, as I mentioned earlier, some well advertised problems with the CPU's, the processing units, the computers, on this system. And we are probably going to end up replacing them at some point with a more modern machine. And I think that we should anticipate soon, because the computer field has moved so fast in the last 10 years, and this design is about 15 years old.

Mr. WINN. Thank you very much.

I think it's pretty obvious from those answers, Mr. Chairman, that we can—this subcommittee and the full committee—can anticipate some additional requests for funding. Thank you.

Mr. ANDREWS. I'd like to recognize my good friend from Florida, Mr. Bill Nelson.

Mr. NELSON. Thank you, Mr. Chairman.

Good morning, Mr. Beggs.

Mr. BEGGS. Good morning, sir.

Mr. NELSON. Earlier in response to Mr. Lujan, you had said, quote—in the shuttle-derived vehicle you said "that will not get a good hearing." Could you explain your feelings there?

Mr. BEGGS. Well, the way the Air Force has drawn the RFP, it clearly—the evaluation criteria in the RFP will clearly not give the shuttle-derived an equal hearing with others.

In the first place, the RFP explicitly says—I just found this one out the other day—that the RFP explicitly says that we will use the Titan facilities, which, of course, takes away one of the major advantages of the shuttle-derived, and that is we can use common facilities and a common group of support personnel.

In addition to that, it requires that the system be operational in 1988 and suggests—not suggests—it mandates that the technology that you use be mature. Now clearly the Titan technology and the—the Atlas technology is more mature than is the shuttle technology. And the 1988 date, which is——

Mr. NELSON. Yeah.

Mr. BEGGS [continuing]. Which is a close-in date, and the fact is that they've slipped some now in going back to the more normal means of funding this program, will mean that the shuttle-derived be adjudged, I am sure, to be of higher risk. All of these will militate against a selection of shuttle-derived launch vehicles. Unless they redraw those evaluational criteria, it's going to be very hard for the shuttle-derived to be competitive.

Now I've written a letter to Secretary Aldridge pointing this out to him, because he has stated publicly that he wants a competition. In order for there to be adequate competition, the ground rules will have to be written, or at least modified, so that the evaluation criteria do not work against a competitive procurement.

Mr. LUJAN. Would the gentleman yield for just a minute——

Mr. NELSON. Sure.

Mr. LUJAN [continuing]. Because that brings up an interesting question. We—we've been hearing about the shuttle-derived vehicles now.

Is that just a concept now, or are we pretty well along the line?

Mr. BEGGS. Well, we've been studying the—the shuttle-derived vehicle down at the Marshall Center for really about the last 3 or 4 years. So it's not a new idea, and it's been discussed with the DOD before. Because there is a long-term need, there's at least an impression in everyone's mind that, in the long term, we're going to want a heavy lift capability. The military has—has had a long-term requirement, and so has NASA. By heavy lift, we're talking about a quarter of a million pounds or more to low Earth orbit and, of course, that's four times what we can get with a shuttle. So that need has been perceived, and we have been working the various concepts where we could get that, and we have a number of ideas on how we can do that.

Now we haven't gone out and tested any of these. They would be new developments and would require both a desired period of design and a period of tests before they became operational. But I might add so does the upgraded Titan and so does the upgraded Atlas require a design period and a test period.

Mr. LUJAN. Thank you.

Mr. NELSON. So the change in the RFP by the Air Force was only a change in the way that they proposed to fund the 10 ELV's, not a change in which there's a genuine competitiveness with a shuttle-derived?

Mr. BEGGS. That's essentially correct, Mr. Nelson. There have been no changes that we have seen in the RFP.

Mr. NELSON. How do you respond to the Air Force's contention that indeed they do need the additional launch facilities, that they don't want to put all of their launch facilities on the same pad from a security factor, that if they have what they call—and I think Mr. Aldridge's word is "complementary," it's not backup. It is either complementary launch capability or, at one time, he might have used the word "supplemental." Their theory is that they, for security reasons, need separate launch facilities from the shuttle pad. What's your response to that?

Mr. BEGGS. Well, if they do, they do. There's no reason, though, when you upgrade the Titan pad that you couldn't upgrade to launch a shuttle-derived.

As I said earlier, though, the security, the assurance of having a launch facility available to you when you want to launch is something that, from a secure point of view—from a security point of view, is very hard to justify.

You're going to have three pads to fire the shuttle, one on the west coast, two on the east coast. Would another one or two be all that much more secure? I doubt it. They are both in the same geographic location. As I said, they're large, they're visible, you can't really protect them against attack. If someone wants to take one out for whatever reason, it doesn't take much of a military brain to figure out how you do that. It's a relatively soft target. And if you put a booster on it, it's even softer.

But, if they need another pad, it wouldn't cost all that much more. As a matter of fact, I would argue that if you did it from the beginning, it probably would cost the same to modify that pad to fire the shuttle-derived, launch the shuttle-derived, just as easily as to launch the Titan or the upgraded Atlas.

And—so I have no quarrel with that. In fact, I want to make that point clear. I have no quarrel with their need. If they have a requirement, I'm not going to gainsay that. If the military has a requirement for more capability, then they ought to have more capability. That's something only they can decide.

All I can argue is that, from the point of view of this program and from the point of view of cost to the country, the total cost to the Nation, it would be a significant cost saving if we can share the production base and the capabilities that exist, or will exist.

There's been some argument, well, we're going to run out of this or run out of that. I even heard one argument put forward that there's not the capacity to make the fuel. That's errant nonsense. There's more than enough capacity.

Mr. NELSON. All right.

Mr. BEGGS. Everything is there, in short, to use it if they want to use it.

Mr. NELSON. Well, it seems like to me that we're at a critical juncture here of trying to figure out what is going to be our transportation system. In 1972, when the policy was set down, we were to develop the transportation system. And when I arrived here on the scene in the late 1970's, in scrimping and getting additional dollars in the supplemental, that was what it was for, the transportation system.

Now you just indicated you had no quarrel with them if they had determined that they needed a supplementary capability.

Mr. BEGGS. That's—I have no quarrel with—if they in their deliberations need supplementary or complementary facilities to give them the assurance of their mission, as I say, I can't quarrel with that because I don't know the basis of it, and presumably they do. They've done a study on it.

But I can argue very vigorously that if they're going to have to have that, it should be something that contributes to the prime capability, that is the shuttle. If the shuttle is the prime capability, then these other efforts which are subordinate to it should be designed in such a way as to support the whole, and the whole is—relies on the shuttle as the centerpiece. And, therefore, it makes sense to me that you design a system that takes advantage of the shuttle technology, which is the best technology you have available today, which surely you would want to do. And, furthermore, it allows you to spread the cost over a larger number of flights and, therefore, lower the cost for everybody.

Now, I cannot see how it benefits to set up still another structure, still another infrastructure of an army of people, additional facilities, additional logistics, and all the other things you need to operate a completely separate system.

Mr. NELSON. If your analysis of this RFP is correct, and that it is in fact a foregone conclusion that the shuttle-derived vehicle is not in contention and that the award will go to either a souped-up Titan or a souped-up Atlas, that being the case and their 10 or more payloads—and I say or more—will be taken off of the shuttle manifest in the future, at first blush, that would tend to make one think that there will be less payloads on the shuttle and, therefore, there will be less frequent flights. If there are fewer flights, then you get back into a problem with your pricing, don't you?

Mr. BEGGS. It will severely impact our costs if they take more than two a year off. Even if they take two a year, it will impact our costs, of course. But two a year, considering the fact that their projections are they're going to fly six or eight times in the outyears, is not a terribly severe impact. If they fly more than two a year to the extent they take a couple more off, it starts to hurt, and—and it will affect our ability to move to a full operating cost recovery on the system, which is our intent.

Mr. NELSON. And——

Mr. BEGGS. I don't know—I don't know that—I can only take what they say at face value, and that is that they only intend to fly twice a year.

But the problem with that, as I responded earlier to a question, is that in those years when you start to approach them, they can save a lot of money by flying more than twice a year, because they to the extent they've got a separate capability by flying it more times, because the systems are very sensitive in a cost way to flight rate, they can save money by flying their expendable more times and flying fewer times on the shuttle, because taking payloads off the shuttle doesn't cost them anything. And I don't know how you can correct that, as I don't know how you can get to a point where you charge them more, because we've agreed that we'll, in effect, single price this system for a term.

Mr. NELSON. Let's suppose that these 10 ELV's have become reality, and we're looking through the 5 years all the way through 1992, and then the question of security becomes a question to the Air Force, as you've outlined the soft targets here earlier, and then let's build on something that Mr. Lujan said earlier, that, in fact, that something might be developed for the Air Force to get into space from his Air Force base runway. Where does this leave us with the shuttle? If the Air Force starts to develop some new capability building beyond the ELV's that is not directly the shuttle, what does that do to the shuttle?

Mr. BEGGS. Well, I would hope that if they headed in that direction, that we would at least have a joint program of development, because clearly what they would be doing is building a replacement for the shuttle if they did that. And if you're going to a replacement for the shuttle, I think it ought to be, again, a national capability to serve all our needs. And I think there will come a time when we're going to want to do that. And I expressed earlier that I'm for that initiation of that work probably sometime in the early 1990's or toward the—certainly by the mid-1990's, we should be beginning to do that.

But I would hope that the DOD would not go off on their own, but that we would at least, if they wanted to do that, make it joint.

Mr. NELSON. By some of the flirtations with the thought of commercializing the shuttle, isn't that encouraging just exactly that goal, that you get the Air Force to peel off the shuttle?

Mr. BEGGS. Well, the Air Force does have a problem, and I—being a customer of the system, I've got to be sensitive to that problem. And that is that this is—this is not a—a normal relationship from their point of view. That is to say it's strictly an agreement between, in effect, two equals. Admittedly, one of the equals is larger than the other and has bigger horses.

But, it's two agencies which agree to do something with each other, and we've agreed with the only mechanism that we have in the government, and that is a memorandum of understanding between us. That's not normal for them. Normally they buy their services on contract, and they can't write a contract with us. At least my lawyers tell me that such a contract would have no more standing than the memorandum. We can't go to court and all those other things to enforce the contract. About the only appeal they have is to appeal to the White House, to the President, if they have a grievance with us. And if the President turns out to be sympathetic to them, then they'll win; if the President turns out to be nonsympathetic with them, then they won't win.

So they worry about that, and they'd like to have a system set up where they can do it on a more normal basis, and I think that's reasonable. That's why I said earlier I think we ought to move to a situation where they can contract as they contract for other goods and services, products and services. And that should give them the necessary assurance that they'll get what they bargain for.

Now, will that have any impact on future developments? I would hope not. The point is that this will be an operational system. It's sort of the same kind of a thing that one has when one puts a military airplane in production. It's operational, its produced. If you want to go on to the next generation, you go out and develop something brand new, and you do that in a normal development way. And I would hope that, when we reach that point with our national space launch capability, that we would again get together and, decide just as we did in the shuttle—decide what we want for the future and set out the concept and proceed with a development program that would encompass both the military needs, the NASA needs, and the commercial needs.

Mr. NELSON. Mr. Beggs, my—the concern that I'm trying to express with my question is that there is talk, some of which you have generated here today, about talking in the future of spinning off shuttle operations to the private sector. And the nature of my question is, were that to become a reality, does that not encourage the Air Force all the more to go do their own thing instead of relying on the shuttle?

Mr. BEGGS. Well, they contract for both hardware and—hardware, software and services with the private sector across the board. They rely on the private sector quite extensively for service backup for them. I see no reason why a private organization could not serve the military just as they serve the commercial market. They——

Mr. NELSON. Well, if there's as much sometimes a strain as we have between two government agencies that are extremely technically oriented and security oriented, et cetera, et cetera, I would tend to think that there might be greater strains if you are dealing not with NASA, but with the ABC Company.

Let me ask you this. If the—as you said earlier——

Mr. BEGGS. Mr. Nelson, may I make another point——

Mr. NELSON. Sure.

Mr. BEGGS [continuing]. That I should have made on your question?

The plain facts are that, in this area—that is launch services the military buys its launch services from private concerns in the—it has for many years in the ELV area. In the Titan area, they don't operate the launch facilities, though, they contract with Martin to do that. In the Atlas arena, they contract with General Dynamics. General Dynamics or Martin is responsible for producing the vehicles, for putting them on the pad, and for launching them. To be sure there is an Air Force contingent, both at Vandenberg and down at the Cape, that is there to ensure that they get what they bargained for and to assure safety of operations. But the job of building and launching facilities is done by private companies now.

Mr. NELSON. And they do that very well.

The difference, however, in the two ideas that we're expressing here is that, in the case that you just cited, Martin works directly for the Air Force.

Mr. BEGGS. Yes, sir.

Mr. NELSON. We are drawing a hypothetical where there would be the ABC company that would be running the shuttle, and it wouldn't be running the shuttle just for the Air Force. It would be running the shuttle for its own self as well as any customers that it might have——

Mr. BEGGS. Well——

Mr. NELSON [continuing]. Such as the Air Force.

Mr. BEGGS. I don't know of any commercial payloads that flew on Titan, but there were a lot of commercial flight payloads that flew on Atlas, Atlas/Centaur. In short, the Atlas system served both the military and it served the commercial community. And that worked reasonably well. The cost basis for that service was agreed upon. And when the DOD wanted to use the Atlas, Atlas/Centaur, they used it without any great difficulty and——

Mr. NELSON. Well, let me just tell you that——

Mr. BEGGS [continuing]. Without any complaints that I know of.

Mr. NELSON [continuing]. My instincts are saying that I would have serious concerns about the elimination of NASA as the organization that runs the space shuttle and turning it over into an ABC company to do that in the private sector.

Mr. BEGGS. Yes, sir. And I understand that concern. And there is always a question mark when I say there are several options here as to how one proceeds with them, and we've got to do this planning and evaluation of the various options very, very carefully if we're going to get there, if we're going to get to and maintain a satisfactory operating environment.

I just think that from the point of view of the future of this system, as well as the future of NASA as an R&D agency, that we owe it to both the committee and to ourselves to go look at this very carefully as to how we want to operate what will be a very, very large responsibility when we start flying 20 or 25 times a year.

Mr. NELSON. All right. Let me just see if I can summarize my concerns on the overall subject of the Shuttle and how this interplays, and then any comment that you would make would be most appreciated.

It seems like that we have several different factors that are going to tell us whether or not we're going to have a viable space transportation system in the shuttle. One of those factors is, will the Defense Department continue to be a good client of NASA and the space shuttle system. Now I assume that it will. The Air Force has spent an awful lot of money at Vandenberg, and, you know, there's every reason to think, but we're suddenly confronted with something new, that they're saying that they want this supplemental 10 ELV capability over 5 years—so that's a new factor—and how that impacts the shuttle, lessening the frequency of the flying which raises the per-flight cost, which you've said. And when that happens, that makes us less competitive. If we're going to have a true pricing policy for our cost, we become less competitive in the international arena.

And then on the other hand, because at the same time that we've been encouraging an American commercial ELV market, if we go in and subsidize heavily those shuttle costs bringing price per flight down on the shuttle, then we're turning around and hurting the American commercial ELV market because we've undercut their ability to compete.

Now I'm not sure that I understand clearly where we're going with all these factors influencing us. And if you could give me some clarity as to the future, it would be most appreciated.

Mr. BEGGS. Well, my crystal ball's equally clouded. I wish I could see more clearly what the future holds.

What I do know is that we are doing a pretty good job, I believe. And I say this as a man who has had some experience in business. We're doing a good job of getting the costs down on this system, and we will continue to do that, as I said. We're making good progress on that. Both the production costs of the hardware and the operation of the system, the service capability, we have is getting better. It's costing less with each passing year.

Now that at some point should put us into a relatively good position to maintain a very good competitive position, good competitive posture, vis-a-vis our foreign competitors, of which there will be several in the out-years. In addition to the Ariane, the Japanese will be coming into the market, and, of course, the Soviets have always been in the markets, and there are several other countries which are considering developing a launch capability on their own. So we're going to have some competition out there, and that competition will be there whether NASA stays around or not. But I think it's important that NASA, from a cost point of view, be competitive in those outyears.

To the extent that we lose flights and lower our flight rate, it does hurt us in the pocketbook nerve. Every time we lose a flight, we have to spread the fixed cost over a smaller number, and that drives the cost per flight up. So that hurts. And, we are working very hard, and I think we have bent over backwards with the DOD to develop this system to the point where it meets all of their needs. They have suggested from time to time it still doesn't meet all their needs, and we acknowledge that, that we still have a ways to go to give them everything they want. But we do have programs in place to give them that capability, and they will have it in a few years. They will have all the capability they want.

And, therefore, we have been asking them—you know, we consider you a very good customer. We'll do anything that we can within reason to keep you on the shuttle. What is it that you want? And they said, OK, we—you know, we're satisfied with that. You're still our prime means. But we want to have this supplementary capability.

And, as I said earlier, a couple a year doesn't make any difference, but if it turned out to be four or five a year, it would make a big difference.

Mr. NELSON. Would you comment about the American commercial ELV's?

Mr. BEGGS. Well, the American—the——

Mr. VOLKMER. This will be your last—excuse me. I don't want to interrupt, Mr. Beggs, but—I know this has been very worthwhile and stuff, but we're running in time, we have other members, and if the gentleman from Florida has additional questions after this one, he can submit written ones. We're going to have other written questions. But I'd like to proceed.

Mr. BEGGS. I'll try to be brief, Mr. Chairman.

The commercial ELV market is really not a price-sensitive market. Now having said that, everything is price sensitive if you have a big enough gap. But I have seen no decisions in the purchase of launch services where price was a major factor. And I say that both with respect to the shuttle, to commercial ELV proposals, and to the foreign ELV proposals.

We have received orders where our price has been—been higher, and we have received orders where our price has been competitive. We have lost orders where their price has been somewhat higher, and we have lost orders where their price has been somewhat lower.

But, the main, as we've assessed those competitions, at least as I've assessed it, the real competitive pressure was in several areas other than price. One, most of our customers like the idea of having several competitors in the marketplace, because that obviously keeps competitive pressure on the shuttle. Secondly, they have to have—because they're making big investments in the satellites, they have to have assurance of launch. So they make an assessment of whether they think they will get that assurance of launch from the various offerers. And thirdly, they are, of course, interested in the terms by which they buy. To the extent that you can give them more service in helping them solve problems over the time period as you work with them, that's money in the bank to them, and so they will throw that into the equation.

But they don't make the decision purely on the number that's written down on a piece of paper as the cost of the launch.

Mr. VOLKMER. Thank you very much.

I'd like to have a few questions, and then we'll go to the other members that are here.

As I understand it, the joint endeavor agreement for Microgravity Research Associates took approximately 3 years to approve—in other words, to bring it about. Can you explain the reason for this time period?

Mr. BEGGS. Well, some of them are much more difficult than others. I can't defend 3 years. It's much too long.

But I can defend going through a very thorough and complete analysis of those. In the first place, most of them have to be drawn in such a way as to ensure the company or the organization that wants to join in a joint endeavor agreement that they get some value for it, because we are asking them to spend a significant sum of money when they sign up with a JEA—in short, put money at risk.

On the other hand, the Government has interests to protect, and you don't want to make the agreement so broad that it covers too broad an area of research and, as a consequence, forecloses someone else from taking advantage of a particular area of science or technology in the future.

So it's sometimes a tedious negotiation. They naturally want to get as much coverage as they can and as much exclusivity as they can. We on our side want to limit it, put a fence around it, if you will, to the degree that we can. Most of our joint endeavor agreements, once we have gotten down to the business of deciding we're going to write one, have taken less than 6 months. In fact, we've written them—we've concluded them in 60 days, which I think is really very good. I can't defend 3 years. That's outrageous. And if we're to take several years to get to that point, clearly they'll lose interest and go away, because that's too long.

But we do have—we do have the intent to—our intent is to write the joint endeavor agreement where we have a willing partner in a matter of a few months. I think we can do that.

Mr. VOLKMER. That's basically the guidelines at the present time then, to try to write them with——

Mr. BEGGS. Yeah, within a 6-month period at the outside, but we try to do them more expeditiously than that. But they—sometimes, you know, you get into these tedious negotiations on what they're going to end up with and whether they ought to have more exclusivity or more rights than we would like to give. And I think that's a normal, natural phenomena in this business.

Mr. VOLKMER. I know we have another subject, to get back a little bit what the gentleman from Florida was talking about, a different area. We have the agreement with the DOD, the Air Force, on the use of the shuttle and the reimbursement costs, et cetera.

But what would be—in light of the developments, what do you think would be the possibility of having DOD share in covering some of the fixed operating costs of the shuttle? If we go back to where we started on the whole thing and how it was to be used in a general Government use, including DOD, but now the pulloff with their supplemental ELV's, perhaps we should look at the total costs involved by DOD.

Mr. BEGGS. Well, we've resisted that, as you know, Mr. Chairman. And the reason, of course, is that the Air Force did agree to provide a number of additions to the shuttle program. They agreed to fund completely the Vandenberg facility, they are putting in their own capability to control the system out at Colorado Springs, and they have been supplying us with various services in a number of other areas, including services down at the ETR and range safety and that kind of thing.

The agreement that was initially drawn—and I think it was a reasonably wise agreement at that time because of the anticipation of the flight rate—was that they would pay their share of the costs of operation, taking into account their investment in the system. And to the extent you ask them to cover portions of the fixed price, they would—or the fixed operating costs—they would be, in effect, subsidizing to some extent the commercial and foreign market, which I don't think we would like to do either.

Another alternative, I guess, would be to agree on some kind of charge, standby charge, when they go on the manifest. That is if they agree to fly, let's say, 6 times a year and they come back, as they now have the option of doing, 12 months in advance of the flight and say, hey, we don't want to fly 6 times, we want to fly 4 times, right now they get the 4 flights on the same price per flight as they get to 6, the cost per flight. And possibly we should work out some way of setting up a pricing scheme where they pay to demanifest or take the flights off after we've, you know, set up the capability to fly them. I think I would prefer that than to the other way, because the other way gets too much in the direction of subsidizing other classes of customers.

Mr. VOLKMER. Well they've already, have they not, manifested flights for 1985, 1986, 1987 and 1988?

Mr. BEGGS. Yes, they have given us their plan for that. But, as I say, under the the current rules, it really is not firm until 1 year in advance of the flight. It's not firm in the sense that a commercial flight is firm, where they put down significant sums of money as much as 33 months in advance of the flight, and then pay on a schedule up to the flight. The DOD puts no money down until a year before.

Mr. VOLKMER. I yield to the——

Mr. BEGGS. Where's Chester? I want to be sure I'm right on that, I think——

Mr. VOLKMER. I agree with you that I think something needs to be done to try to assure that, if they are not going to utilize the shuttle, at least that they make some payment for those that have presently manifested. If we take the philosophy of the administration, as expressed at least back in 1982, that the DOD is the primary user, then if we had the primary user backing off, I think we're in a serious problem.

Mr. BEGGS. Well, in all fairness, they have not backed off. They still claim that they will remain a primary user and that they intend to use the shuttle as their primary means of getting into space. As I have said to several of you in the past, somehow I worry about that.

Mr. VOLKMER. All right.

The last part I'd like to talk about is—and if you would rather the next panel address this, it would be all right to say so—there is a question I get on the logistics on spare parts and how that's going to be developed and when we can see a final decision being made, how it's going to be operated. If you would rather Mr. Moore and the others to address that, I'd be glad to wait.

Mr. BEGGS. I think Jess Moore's in a better position to answer that.

Mr. VOLKMER. All right.

Mr. BEGGS. We are proceeding with a plan. As time passes, we're getting better and better in our ability to have spares available when we need them.

Mr. VOLKMER. At this time, I'll yield to the gentleman from Pennsylvania, Mr. Walker.

Mr. WALKER. Thank you, Mr. Chairman.

Is there any other transportation system other than the shuttle that is at all compatible with the space station?

Mr. BEGGS. Well, I'm hesitating, Mr. Walker, because since we haven't designed the space station fully, we probably don't know. There is no reason why other transportation systems could not be compatible with the space station though.

Mr. WALKER. Well, the point I'm making is that isn't it logical to assume that, in terms of building the space station, ultimately servicing the space station, certainly putting people—bringing people back and forth to the space station, the shuttle is going to be the primary vehicle for—for space station activity?

Mr. BEGGS. The logic of the thing says that, because the shuttle will be, we expect, operating frequently in the 1990's, so it can do that job on an incremental cost basis, which is to say that they can exchange crews from time to time, they can drop off consumables, they can change out various payloads in the space station by loading those on the shuttle at the same time the shuttle is flying on other missions, say, putting a satellite in orbit, because it will be expected to be in a 28½ degree inclination, which is the normal orbit we use. So, from the point of view of the facility of servicing, that's true.

But there's no reason why if, for example, the French wanted to come along with something like the Army's vehicle that you talk about, that they could not as well come by and work with the space station or with any of the platforms that are associated with the station.

Mr. **Walker**. Well, the point I'm getting to is, so long as the—as we pick up and maintain our commitment to the space station, the—therefore, at that point, the future of the shuttle seems to be almost assured. If we're going to have the space station, you can't very well have it—you can't have all the attendant things that would be with the space station without having the commitment to shuttle. Isn't that a logical——

Mr. **Beggs**. Well, we have made that assumption. Clearly the country has gone forward over the last 12 years to build this system as its prime national capability for servicing any of the future endeavors we undertake in this program, and we've invested over $20 billion in it. And it seems to me prudent that we use it to its maximum efficiency and effectiveness.

Mr. **Walker**. It is, in fact, the truck to haul back and forth the materials that may be produced in space that are associated with the space station?

Mr. **Beggs**. It has that capability, yes, sir.

Mr. **Walker**. And the fact is that, when you get to the point that you build industrial things in space to that space station, it is also logical to assume that we may have to put on more flights for shuttle in order just to do that servicing capability?

Mr. **Beggs**. Well, we don't think it's a large number of additional flights. And the reason is that which I said before, which is that we think we can do this as a subsidiary flight responsibility. There will be some dedicated flights, but we think they're relatively few in number, maybe six or eight over the next—well, over the 5 or 6 years that we'll be operating it.

Mr. **Walker**. I'm thinking more, though, of the practical application of actually making products in outer space when you are then going to use on Earth. You are not going to have manufacturers, investors, who are going to be willing to commit themselves to only getting their product when and if NASA decides to fly. You are going to have to assure them, it seems to me, some consistency in flights that would assure them that they would have a product arriving back at their processing plants on Earth on a fairly regular basis.

Mr. **Beggs**. We should be able to give them that assurance if the system develops as we anticipate it will. Because if our flight rate builds up to the 20 or 25 per year level, we will be able to call by fairly frequently.

Mr. **Walker**. You made a statement here a bit ago that the ELV market is not price sensitive. I think you went into a logic that it's——

Mr. **Beggs**. I said the launch——

Mr. **Walker** [continuing]. Not purely price sensitive.

Mr. **Beggs**. I think I said—if I didn't, I should have—that the launch services market is not price sensitive, whether it be ELV or shuttle or whatever.

Mr. **Walker**. All right. That does—that makes it a little bit different from what I understood before, because—my question then is, why then would shuttle pricing be important? If ELV is not price sensitive, then it seems to me that you—that the pricing on shuttle would have to maintain the same logic. If it's launch services we're talking about, that is a somewhat different direction.

Mr. **Beggs**. Let me go back, if I may, Mr. Walker, and review the history of this thing. At the time, we made the decision on pricing on the shuttle, we decided to flat price it. By that, I mean that we would charge a flat price over a mission model.

Now things have changed over the time period that we've started operating. In the first place, we haven't built up to the flight rate we anticipated we would when we set out that pricing philosophy. And in the second place, the costs that we have experienced are a good deal higher than we anticipated at the time we set that flat price. Therefore, when we got around to—to pricing the—but we did price the first three years on that basis, and we're just about to fly out at the end of next year the—the last year of that first 3-year pricing policy.

But that was set, and it was sold out, the capacity was sold out on that basis. So we had binding contracts or agreements with the various people on the basis of that price.

Mr. **Walker**. And I think most of us recognize that there was—that because it was a developmental vehicle, it was a research vehicle, at that point, it was logical to set the price differently at that point.

Mr. **Beggs**. Well, there've been people who have quarreled with me on that point, but I agree with you that that was the logical thing to do.

Mr. **Walker**. It was logical that early.

Mr. **Beggs**. But in spite of that, I might add again in defense of the DOD, when I got here in town, we went back and raised the price to the DOD, and raised it a third, which is not insignificant, and they swallowed that. That means that they are paying significantly more than they intended to pay in that first 3-year period.

But, anyway, with those exceptions, we had sold out the first 3 years. Then came the question, because we had customers coming to us asking us for prices on the subsequent 3 years—on the next 3 years, 1985 through 1988—what was our price going to be then.

So we had to make a decision. Recognizing as we did in NASA that we would still be developing the vehicle, the technical capability of the vehicle through that period, probably to 1988, because we knew at that time what our technical—what the technical issues were, we should price-start to move in the direction of covering our costs. So we thought long and hard on this and decided to price it on the basis of the way we had generally priced R&D services in the agency, that is to recover, in effect, the additive costs that we would have in the system.

And we said at that time that we would then in the 1988 time period move to a philosophy of full operating costs, covering full operating costs. That's still our intention. That's been our basic pricing philosophy, throughout. And it's been—and I might emphasize that it's been very well advertised both in the press and to anyone who is in the industry as to how we intended to proceed with that. Nobody—I hope no one's been in doubt as to our intention there, because more and more people are starting to ask me why aren't you on a full cost recover basis. And I say, gee whiz, you know, we went through this, it was open, it was broadcast, it was widely known what we were doing, and there weren't any complaints at the time, but now there seem to be a lot of issues being raised as to why we're pricing on the basis we're pricing.

Mr. **Walker**. Well, I guess one of our problems is whether or not we can establish just what that price is. Can if not right here, for the record, can you give——

Mr. **Beggs**. Well, the price that we charge for a full launch is $71 million a flight——

Mr. **Walker**. OK.

Mr. **Beggs** [continuing]. In 1984 dollars——

Mr. **Walker**. What I——

Mr. **Beggs** [continuing]. Current dollars.

Mr. **Walker**. What I'm looking for is what——

Mr. **Beggs**. In 1983 dollars, all right. You're going to make me——

Mr. **Walker** [continuing]. Is the difference in the costs—between the costs of the shuttle launch, including all associated repair and refurbishment, and the price paid by commercial users?

Mr. **Beggs**. I would guess that if you—well, you can arrive at that in several different ways. You can take the total operating budget in the manned space program and divide it by the number of flights. I would suggest that's really not fair. But that runs in the order of $150 to $200 million——

Mr. **Walker**. So is——

Mr. **Beggs** [continuing]. A flight. So, it's about twice what we're charging or better.

But as I say, that's coming down fairly rapidly. My anticipation is that in the 1987-1988 time period, that with a price somewhat higher than that $71 million, maybe 25 or 30 percent higher than that, that we will be on full cost.

Mr. **Walker**. Well, OK, that's what I'm trying to get here.

Now the different—the $80 million of difference right now is, in fact, a subsidy.

Mr. **Beggs**. Well, I——

Mr. **Walker**. If you're saying $150 million is what——

Mr. **Beggs**. I guess you could define it that way. I would prefer to look at it a little differently. It's not a subsidy, it's a continuation of our philosophy to recover our costs over a time period.

Mr. **Walker**. OK. Well——

Mr. **Beggs**. If you go into if you go into——

Mr. **Walker**. It's a subsidy, though, for the guy that's looking at your——

Mr. **Beggs**. If you're building automobiles, Mr. Walker, and you build—you decide you're going to develop a new automobile and you're going to put it on the market, what you do is you say to yourself I expect to sell a million of this particular automobile. And then you price the automobile, not on the basis of what the first 1 or the first 10 or the first 100,000 cost you, you price it on the basis of recovering—of making a profit on some break-even volume, which if you expect to sell a million, you'd probably set it at half a million, if you're conservative. So that you try to recover your costs over some discrete number of units, and that's the philosophy we've adopted in pricing the shuttle, that we would try to recover our costs over some discrete number of units.

Now you asked me what is that number, and I've got to respond to you that I don't really know right now, but it's something less than the 500-odd than that we set initially—512, I think, or thereabouts.

Mr. **Walker**. Well——

Mr. **Beggs**. And something more than the number that would be implied by the current pricing.

Mr. **Walker**. I think what the commercial user is concerned about also is that he's at collapsing—OK, you say that you're going to raise the price by 20 to 25 percent over the $71 million that's now being charged. That—that—that gets us up to about——

Mr. **Beggs**. I said 25 to 30, but——

Mr. **Walker**. OK. Well, somewhere around $100 to $110 million?

Mr. **Beggs**. Well, no. That would work out to be something less than 100.

Mr. **Walker**. OK, something less than 100. You're going to bring down your costs. Are your costs ever going to get down to that something less than 100?

Mr. **Beggs**. You bet.

Mr. **Walker**. OK. You see that the collapsing, you see—if I understand the logic you are now using, you see them passing each other, where the $90 million or so, the $95 million is, in fact, going to be a higher cost than the actual launch services, and that that is going to be enough money ultimately to pay back that which some people would call subsidy today?

Mr. **Beggs**. Yeah, we are going to be applying this thing for 25 years.

Mr. **Volkmer**. Would the gentleman yield?

Mr. **Walker**. I would be delighted to yield to the gentleman anytime.

Mr. **Volkmer**. I'd just like to ask a basic question.

Mr. **Walker**. You've been more than generous with time.

Mr. **Volkmer**. I know. And then we're going to have to—we still have one member left.

But to get back to this, the way I see it—and you correct me if I'm wrong and try and maybe supply it a little further—that if we started trying to recover full costs, and have last year and this year, wouldn't we be subsidizing the later users if we continue to maintain that cost, and then bring down—you are going to be bringing them down, the costs, later on——

Mr. **Beggs**. Well, in a sense, yes.

Mr. **Volkmer**. The development costs, et cetera, would be subsidized in later users.

Mr. **Beggs**. Yes, sir, in that sense.

But, as I say, I don't know how you would—in a commercial world—or even in a non-commercial world—in a world where you are dealing with a new product or a new service which is going to be sold for a long period of time, I don't know how you avoid that particular problem.

Mr. **Volkmer**. All right.

Mr. **Beggs**. Because clearly you're not going to come on the market with something where you've priced it out of the market to begin with. So you hope to recover some of your costs in the later years as the system becomes mature. And this is no different than that.

Mr. WALKER. Thank you.

Mr. VOLKMER. I recognize the gentleman from Florida.

Mr. MACKAY. Thank you, Mr. Chairman.

I just need to get a little better idea from a perspective standpoint of where it was we were trying to go when we started down this road. I think I understand where we're trying to go now, but it doesn't seem to me that our destination is the same as it was.

I thought this was a research program, and I thought part of the effort was to develop a reusable space vehicle, and that was a research program. And it seems to me that we're still involved in that research program, and that that part of the costs of putting the shuttle up, bringing it back, modifying it, getting it ready, launching it again, the crew costs, that relates to that research is not a subsidy to anyone.

Now, am I missing——

Mr. BEGGS. Well, that's my assumption as well, and I think that's been the agency's assumption, that the R&D costs of this system would be considered a national investment in building both a body of knowledge and the capability——

Mr. MACKAY. So I——

Mr. BEGGS [continuing]. And that we would not recover that. And to my knowledge, it never has been our intention to recover that R&D program's costs.

Mr. MACKAY. So, without any subsidy, since we're engaged in a research program anyway, so long as we're pricing the shuttle launch services at a figure that recovers the marginal additional costs of putting somebody's load up there, then we're recovering the Government's cost, if you assume——

Mr. BEGGS. Yeah. But we're not at that point, Mr. MacKay, and that was really the response I gave to Mr. Walker. We are not at the point of recovering the full operating costs of the system.

Mr. MACKAY. But I don't understand full operating cost, and that's what I'm trying to get you to——

Mr. BEGGS. All right. Let me try to define what we mean by operating cost.

We include in operating cost the costs of the team that we have at Kennedy, at Marshall, at Johnson, which are necessary to fly the system safely and efficiently——

Mr. MACKAY. Now that——

Mr. BEGGS [continuing]. As well as——

Mr. MACKAY. Is that part of your research cost?

Mr. BEGGS. No, sir. That's just the cost of getting the—the vehicle in orbit, maintaining the safety of the vehicle while in orbit, and doing the particular mission we're trying to do while in orbit and getting it back to a landing site safely. And then——

Mr. MACKAY. Well, wait a minute.

Mr. BEGGS [continuing]. The costs of refurbishing the vehicle for the next flight, and the cost of the consumable items, the external tank, the fuel of the solid rocket boosters, the refurbishment of the solid rocket boosters, and the other fuel that we use, fuel and supplies that we use, in flying it—those costs.

Mr. MacKay. I have to say I'm surprised at that answer, because it seems to me that carries with it the implication that, if we end up not being competitive, we're not going to do any more research. And that's the darnedest thing I ever heard.

Mr. Beggs. Well, I hope that isn't——

Mr. MacKay. Now what if Ariane——

Mr. Beggs. I hope that isn't what I——

Mr. MacKay [continuing]. And Atlas and others come in and they say, well our cost is $40 million?

Mr. Beggs. I hope that isn't what I implied, because I don't believe that. What I do mean is that, in the long run, the basic pricing philosophy that we have followed for quite a while in this country on launch services, whether it be ELV's or shuttle, is that we would recover the—the full operating costs of operating the system. And we've done that. In the case of the Atlas and in the case of the Delta vehicles, we've recovered the full operating costs over time.

We have never, however, tried to go back and recover the R&D costs of developing those vehicles, to my knowledge, nor are we asking today when we're turning those vehicles over to a private operator—nor are we asking them to pay any additional cost to recover any of the costs of developing the vehicles, or even developing the capability to produce them, the initial tooling and what have you. All we've done is say you pick them up and sell them at whatever price makes sense to you so that you can earn a profit in operating that system.

The same is true of the shuttle, that we would never try to go back and recover the R&D costs, but that we would try eventually to get to a point where we recovered full operating costs. And that's still our intent.

But I hope that doesn't imply that, when the time comes in the future that we want to do further research and development on, let's say, a new system or an upgraded system for launch services, that we would expect to earn that money out of the operation of the shuttle. I think that would be a tragic mistake for this country for a number of reasons, not the least of which none of our foreign competitors would operate that way, and it would put us at a severe disadvantage in the future vis-a-vis our foreign friends——

Mr. MacKay. I don't think——

Mr. Beggs [continuing]. Who like to compete with us.

Mr. MacKay [continuing]. I asked the question right, because you're saying some things that make sense, but they're not addressing what I was trying to get at. Let me try a different way.

What if you end up in 1988 uncompetitive? And what if at that time there are enough additional launch vehicles, some of which it seems are going to be developed and subsidized by the Air Force, but are then capable of competing with you for commercial payloads, and what if there are no commercial payloads from which to recover this cost? Now, will we——

Mr. Beggs. If we end up—if we end up——

Mr. MacKay [continuing]. Not still be doing research?

Mr. Beggs. If we end up noncompetitive in the 1990 time period, then would say that we will have to go back to the drawing board and say to ourselves as a nation, what is it that we want to do in space in the future? I don't think this country's going to quit its space exploration in 1990 or 1995, regardless of what happens in the competitive marketplace.

Now the shuttle gives you a fairly unique capability. That's why we built it. It allows you not only to go up and place things in orbit, it allows you to go up and service those things, to repair those things. It also allows you from time to time to go up and pick up things and bring them back.

Mr. MacKay. I fully agree with that.

Mr. Beggs. And it allows you to operate in a more or less permanent way by going up and building a more permanent facility like the space station. None of those things can be done by the ELV's. Therefore, in my view, the capability is always going to be necessary. If it turns out, however, that we are noncompetitive in the commercial marketplaces, clearly we'll lose the commercial payloads, except those commercial payloads that we can convince that our capability to service them more than pays for the additional cost.

Having said all that, Mr. MacKay, I do not believe that the shuttle system will end up being noncompetitive. I really don't. I think that the system costs—there's no reason why this system, from a cost point of view, cannot be competitive.

Now if we're not capable of making it cost competitive at NASA, then that's still another reason to turn it over to somebody that can——

Mr. MacKay. Well, I——

Mr. Beggs [continuing]. Because there's nothing inherent in this system that makes it cost more per payload, if you will, per satellite put in orbit or anything else, than an expendable.

Mr. MacKay. I just——

Mr. Beggs. It's just not inherently more expensive.

Mr. MacKay. It does not seem to me appropriate for us to—or for you to be required to adopt a policy that you've got to recover operating costs, when I would say the appropriate thing to have said would be we're going to recover the marginal costs of that part of the payload which doesn't have to do with our research.

Mr. Beggs. That's what we're trying to do now with the policy that we have for the forthcoming 3 years, in essence.

But our view was that when we set that, when we looked at the outyear costs, that we were on a good enough learning curve that we could anticipate that when we got to 1988, we would be in a position to competitively recover the operating costs. Now if we're not, I guess my successor will have to worry about that. But if we're not, we're going to have to go back to the drawing board and decide what we do, because that will be something that will require some agonizing reappraisal.

I happen to believe, however, that the path we're on will get us there. And hope that the committee will have enough confidence to stick by us, because we're not doing something that—that you can't walk back if it turns out to be wrong. You can walk this cap back in 1988 if it turns out that we've made the wrong judgments.

But I think you ought to let us try to do that, because I think it's important for us to try to do that. I think it's important for the Nation that we try to do that, to make this system as competitive as we can.

Mr. **MacKay**. I'm out of time.

Thank you, Mr. Chairman.

Mr. **Volkmer**. I thank the gentleman from Florida.

Thank you very much, Mr. Beggs. I'm sorry I wasn't here at the beginning of your statement, but I had to come in from Missouri this morning, and flights don't come early enough to get here in time. So I want to thank you sincerely for being here with us, and we appreciate your testimony.

Mr. **Beggs**. Thank you, Mr. Chairman.

[Answers to written questions for Mr. Beggs follows:]

Questions submitted by Chairman Volkmer during the July 31, 1984, hearing at which Mr. Beggs testified on Shuttle operations.

QUESTION A-1:

Given that roughly two-thirds of the Space Shuttle's launch activity over at least the next decade will be in support of U.S. government programs, in your view, would it be wise to spin off Shuttle operations to the private sector?

In your view, would it be wise to have the U.S. Government dependent on the private sector for all access to space?

QUESTION A-2:

What are the advantages, disadvantages, and eventual likelihood of each of the following Shuttle operating alternatives:

- Keep Shuttle operations within NASA as they are?
- Keep Shuttle operations within NASA but "fence" them from other NASA programs?
- Commercialize Shuttle operations?
- Move Shuttle operations to a quasi-government corporation?
- Split the Orbiter fleet into separate NASA and DOD fleets?

ANSWER A-1 AND A-2:

A major NASA objective is to establish the framework and policies upon which to base the organization and management structure for future STS operations. The experience base and maturity gained since the first Shuttle flight, and the current contractor consolidation efforts at KSC and JSC, provide a solid baseline from which to explore new and innovative ideas for future directions of STS operations.

The question of NASA's long-term management role in Shuttle operations has been the subject of several studies in recent years. Most recently, the NASA Advisory Council has concluded that several factors militate against shifting operations outside of NASA in the near future. One of the Council's recommendations was that:

> A new NASA organization be created at the appropriate time within NASA to focus on Shuttle operations and utilizations, including marketing activities and sustaining engineering support. This organization, which should be headed by a Deputy Administrator, should have fenced manpower, finances, and facilities.

More recently, the House Committee on Science and Technology has asked the Agency for a "preliminary timetable for completion of activities to fence all Shuttle operating budgets, facilities and personnel along with the rationale for the timing of each milestone." The Office of Space Flight will address the Committee's specific request in a report to be provided to the Administrator by the end of 1984.

In the longer term, there is a need to address the permanent institutional and management options for the Space Transportation System. To this end, the Administrator has appointed the Shuttle Operations Strategic Planning Group. This Group will be chaired by former NASA Associate Administrator for Space Tracking and Data Systems, Mr. Robert E. Smylie, with membership from NASA Headquarters, the STS Centers (JSC, KSC, MSFC), and non-government organizations/consultants.

The objective of the planning activity is to provide and assess strategic options for managing and operating the Space Shuttle in the late 1980s and beyond which defines the transition steps and milestones, if any, and the institutional setting for Space Shuttle operations.

The group is to address the institutional, financial, business, regulatory, legislative, national security, management, and organizational arrangements that would pertain to various options for future operation of the Space Transportation System.

Possible options to be considered include, but are not limited to:

1. The current arrangement with appropriate modifications (a civil effort under NASA and a national security effort under the Air Force).

2. A separate Space Shuttle Operations organization.

    a. Within the Government (other than Approach 1).

    b. Within a Quasi-government Corporation.

    c. Within the Private Sector.

The group will examine the options, point out advantages, disadvantages and any special Administration or Congressional actions required, and produce a skeleton plan for the implementation of each option for the consideration of the Administrator.

The results will be contained in a report to be provided to the Administrator by the end of the year.

QUESTION A-3:

In your view, what major factors need to be considered in choosing a post-1988 pricing policy for the Space Shuttle?

ANSWER A-3:

There are many National Policy considerations to address in determining Shuttle pricing policies. Additionally, there are other factors such as:

1. The impact on private sector commercial entities, including commercial launch vehicles and upper stages.

2. The impact on international competitive posture;

3. The impact on other high tech commercial initiatives, such as materials processing; and,

4. The impact on the program budget (i.e., taxpayers).

QUESTION A-4:

What are the principal pros and cons of "additive" versus "total" cost recovery as a Space Shuttle pricing policy?

ANSWER A-4:

A purely additive cost recovery policy which is not now being implemented would allow for an internationally competitive price and also permit the industrial entrepreuers to develop or improve technology and products with some extensive, but not excessive risk of capital. This would result in a price of approximately $40M per dedicated flight compared to the current price of $71M in FY 1982$.

Total cost recovery would provide for the commercial customer to pay a pro rata share of the total costs to the U.S. Government. However, the resulting price may be non-competitive for the current spacecraft satellite customers and might result to be too expensive to encourage the developers of new space-based products. A significant increase in pricing may actually increase the cost of maintaining the Shuttle program depending upon the number of customers lost. Total costs, also, vary significantly with the non-government flight rate and can only be determined after the actual costs are accumulated.

Mr. **Volkmer**. At this time, the hearing will continue. We will have Mr. Jesse Moore, the Acting Associate Administrator for Space Flight. He will be accompanied by Michael Weeks, Deputy Associate Administrator, Technical; Isaac Gillam, Assistant Associate Administrator, Customer Relations and Policy; and Charles R. Gunn, Director of Shuttle Operations.

Before we begin, Mr. Moore, I want to just offer my congratulations. I guess this is about the last day we'll be able to call you Acting Associate Administrator, Office of Space Flight. Tomorrow we—as I understand it, we can start calling you the actual Associate Administrator, as I understand it, and I want to congratulate you on that.

Your statement will be made a part of the record. You may review it in full or you may summarize, however you so desire. I understand that you have a meeting at 1:00 o'clock, so we will conclude, however long it takes for your statement, questions by 12:45. That should give everybody plenty of time. And I hope we don't have too many votes as to that time.

You may proceed.

STATEMENT OF JESSE MOORE, ACTING ASSOCIATE ADMINISTRATOR FOR SPACE FLIGHT, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, ACCOMPANIED BY L. MICHAEL WEEKS, DEPUTY ASSOCIATE ADMINISTRATOR, TECHNICAL, NASA; ISAAC T. GILLAM IV, ASSISTANT ASSOCIATE ADMINISTRATOR, CUSTOMER RELATIONS AND POLICY, NASA; AND CHARLES R. GUNN, DIRECTOR, SHUTTLE OPERATIONS, NASA

Mr. **Moore**. Thank you, Mr. Chairman.

Mr. Chairman and distinguished members of the subcommittee, I appreciate the opportunity to testify before you here this morning.

Since the historic flight of *Columbia* in April of 1981, we've flown 10 highly successful shuttle flights. From that historic first flight and the return of our astronauts to a landing strip in California, also from the first flight of a reused space vehicle, the flight of space lab, the deployment of the long duration exposure facility, the flight of the manned maneuvering unit, and the flight of the solar maximum repair mission, I think the shuttle has clearly proven that it's the most versatile space transportation vehicle ever built.

The shuttle has demonstrated its flexibility in meeting customer requirements, despite encountering some technical difficulties and some schedule delays. The decision we've just reached on the inaugural flight of *Discovery*, and the actions that have been taken in moving the cargoes from one flight to another, have strengthened our confidence in our ability to meet customer requirements and in our confidence on the flexibility of the overall shuttle team.

Because of its reliability and flexibility, and in accordance with the President's space policy, the shuttle is the primary launch system for U.S. national security and civil Government missions, and will be used in a number of exciting missions in the near future.

With all of the successes of the shuttle, we are deeply committed to assisting our customers and their suppliers in any way possible using all of the technical expertise we've developed in over 25 years in the space business.

Our goal is to make the space transportation system fully operational and cost effective in providing routine access to space for all users. Our primary concern and objective is that each mission be safe and successful As the Aerospace Safety Advisory Panel reported to you, our safety record has been 100 percent so far, and the shuttle has performed surperbly during each mission.

With your permission, Mr. Chairman, I'd like to read the letter that the Aerospace Safety Advisory Panel Chairman wrote to you on July 5, following the abort from flight 41D.

> As Chairman of the Aerospace Safety Advisory Panel, I believe it is appropriate to comment to you and your subcommittee regarding the auto shutdown of the Orbiter Discovery's main engines during launch sequence on June 26, 1984. The Panel believes it is particularly important to do so in view of the negative connotations in the media reporting of the event, which may have created misleading impressions in the minds of the public regarding the safety of the astronaut crew and the soundness of the space transportation system.
>
> In fact, the system operated precisely as designed. The launch sequence was stopped automatically when the computer detected a mismatch between actual engine start function signals and the pre-programmed, required function signals. Thus, this design safety feature performed as intended to ensure the safety of the crew and the vehicle system. This should bring positive connotations rather than negative ones.
>
> We of the Panel view the space transportation system as a program still in transition from the development stage to the operational stage. Due to the nature of its missions and the necessary complexities of its hardware and software, the transition period will continue for some time into the future. It would be a misconception and an unrealistic comparison to expect airline-type operations from the space transportation system, although it can be noted that even sophisticated jetliners experience some departure delays and occasional cancellations for technical reasons. The important consideration is that each mission be carried out safely and successfully. The space transportation system safety record is 100 percent thus far, and we are pleased to see the design performing to maintain this record.

Other goals that we have in the program, and also ones to which we are deeply dedicated, include maintaining the operational launch schedule, reducing operational costs, and implementing an effective management structure as we enter and plan to go forward in the operational era.

Our 5-year program includes increasing the flight rate to 24-flights per year, improving the space shuttle main engine, increasing the production capability for the solid rocket boosters and the external tanks, improving our ability to land at KSC on a routine basis, activating Pad B at KSC, and supporting the activation of the Vandenberg Air Force Base launch facility in California.

The full 65,000-pound cargo capability will be demonstrated at KSC in 1986—in May 1986, I should say—with the Galileo mission. In order to assure adequate performance reserves for this most demanding mission, the space shuttle main engines will be operated at the 109-percent power level.

At Vandenberg Air Force Base, the space transportation system payload capability will increase as certain performance enhancement measures become available. The lighter weight filament wound case segments in the solid rocket boosters will increase payload delivery capability on the order of 4,600 pounds. The filament wound case will be available for the first Vandenberg flight in October 1985. In accordance with our commitments to the Air Force, the 32,000-pound payload delivery capability will be available at Vandenberg in the 1990 timeframe.

We need to keep reminding ourselves that, while the shuttle is operational, further improvements and refinements are necessary to expand its capabilities and improve its operating characteristics. The orbiter fleet modifications that are currently underway are modifications to Orbiter 103 and 104 to strengthen wings to sustain greater aerodynamic loads, modivations to OV-99 and 104 to accommodate the Centaur upper stage, incorporation of a fifth cryo tank set in Orbiter 104, Atlantis, to achieve additional on-orbit stay time for scientific experiments as we did with Columbia on STS-9, instrumentation of the brake system, and installation of an axle saddle to reduce maintenance costs. Modification of the orbiters was planned to maximize the fleet availability in 1985 when the mission model increases to 11 flights, and to prepare for the Centaur missions in the May-June 1986 timeframe.

Mr. Chairman, I believe the recent Solar Maximum Repair Mission on STS-41C has clearly demonstrated the ability of man and machine working together in space. I believe the results of this mission will have significant effects on our future as we move toward the space station era.

There are many other challenges ahead in the space shuttle program and, as I embark upon my new assignment with the STS team, I am looking forward with enthusiasm to those new challenges.

Mr. Chairman, this concludes my prepared remarks, and I will be happy to answer any questions that this committee may have at this time. Thank you.

[The prepared statement of Mr. Moore follows:]

STATEMENT OF JESSE W. MOORE, ACTING ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE FLIGHT, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and distinguished Members of the Subcommittee: I appreciate the opportunity to testify before you on the Shuttle Program.

Since that historic first flight of Columbia in April 1981, we have flown 10 highly successful Shuttle flights. From the historic first flight and the return of our astronauts to a landing strip in California, the first flight of a reused space vehicle, the flight of the Spacelab, the deployment of the Long Duration Exposure Facility through the flight of the Manned Maneuvering Unit and the Solar Maximum Repair Mission, the Space Shuttle has proven that it is the most versatile space transportation vehicle ever built.

The Space Shuttle has demonstrated its flexibility in meeting customer requirements despite encountering some technical difficulties and some schedule delays. The decision we have just reached on the inaugural flight of Discovery STS-41D, and the actions that have been taken in moving the cargos from one flight to another, have strengthened our confidence in the flexibility of the Shuttle team and its ability to respond to unforeseen circumstances. The Shuttle has been successful in the deployment of five communications satellites, a tracking and data satellite, and flying five major attached science payloads.

Because of its flexibility, and in accordance with the President's space policy, the Shuttle is the primary launch system for U.S. national security and civil government missions, and will be used for a number of exciting missions in the near future including the test and evaluation of a large solar array on STS-41D in August of this year. We are looking forward to the anticipated retrieval mission in November to return the Palapa-B and Westar communication satellites which failed to achieve their planned orbits after being successfully deployed from the Shuttle.

With all of the successes of the Shuttle, we are deeply committed to assisting our customers and their suppliers in any way possible using all of the technical expertise we have developed in over 25 years in the space business, enhancing our ability to provide customer services and ensuring that the capability is available to meet not only our nation's needes but also those of our foreign customers. We are looking at ways we can continue to reduce costs, improve quality, increase productivity, ensure greater customer satisfaction, and explore avenues to enhance commercial opportunities in space.

Our goal is to make the Space Transportation System fully operational and cost effective in providing routine access to space for all users. Our primary concern and objective is that each mission is safe and successful. As the Aerospace Safety Advisory Panel reported to you, our safety record has been 100% so far, and the Shuttle has performed superbly during each mission. Our other goals, and ones to which we are deeply dedicated, include maintaining the operational launch schedule, reducing operational costs, and implementing an effective management structure for the operational era.

Our five-year program includes increasing the flight rate to 24 flights per year, improving the Space Shuttle Main Engine, increasing the production capability for the Solid Rocket Boosters and the External Tanks, improving our ability to land at KSC on a routine basis, and activating Pad B at KSC and the Vandenberg Air Force Base Launch Facility.

Our baseline plan is to land all of our missions at the Kennedy Space Center, except those missions which must go to the Dryden Flight Research Facility, such as those involving the first flight of a new orbiter, performance of a development test objective such as autoland, or potentially hazardous weather conditions.

The STS mission model is continually being updated as the STS traffic is manifested, as projections are refined, and as the Shuttle fleet approaches full operational status. The Shuttle flight rate is scheduled to ramp up to 24 flights per year by 1989 with a four-orbiter fleet and includes four flights in FY 1984 with 11 planned in FY 1985—all from KSC. An important milestone in the program is expected to be reached in October 1985 with the first flight from the Vandenberg launch facility. In FY 1986, we plan to launch 16 flights. FY 1986 will be a particularly significant year for the STS, as we will launch our first Centaurs on the Shuttle for Galileo and Solar Polar in May 1986 and the Space Telescope in August of that year. Projections indicate that approximately one-third of the payloads in the upcoming years will be commercial and foreign missions, one-third are NASA, and one-third will be DOD.

As you are aware, Shuttle manifesting is being affected by the problems that the Payload Assist Module (PAM) is experiencing. The commercial developer of this upper stage completed a development program which was monitored by NASA under the terms of agreement between the developer and NASA. Eighteen PAM's had been flown successfully, 13 on ELV's and 5 on the Shuttle, when the two PAM failures occurred after being launched from the Shuttle on our STS-11 launch on February 3, 1984. The developer immediately initiated an investigation into the failures to ascertain their cause and to determine the necessary remedial action to prevent their recurrence. At the request of the contractor, NASA has supplied observers for the investigation activity.

Very early, the investigation centered on the motor nozzles as the source of the problem. At this stage of the investigation, the contractor has utilized new nondestructure testing techniques including CATSCAN (Computer Assisted Tomography) and high energy radiography to select good motor nozzles. Two nozzles selected by these proceses successfully flew on an Air Force mission since the Westar and Palapa failures. McDonnell Douglas is doing an evaluation of the results of recent test firings using an arc jet test facility which appears to simulate the thermal loading on the nozzles. Nozzles evaluated as both "good" and "bad" by the nondestructive test techniques will be fired in the facility. While the PAM has been commercially developed, it is important for us to understand more fully the Solid Rocket Motor process. Application of the composites used in the PAM, as well as most of the solids, including the Solid Rocket Motor that we utilize with their superior properties, is important to maintaining an overall competitive position. We are putting together at the Marshall Space Flight Center a program which will provide the government data about this crucial technology, help improve the fundamental body of knowledge used on high performance nozzles, and be responsive to the request from your committee.

We are in the middle of a period of evolution from Space Shuttle research and development activities to full operational status. Efforts are underway to reduce the near-term Shuttle vehicle launch processing turnaround capability to 35 workdays. Turnaround improvements necessary to achieve this 35-day generic timeline, such as lightweight Space Shuttle Main Engine heat shields and interchangeable OMS Pods, have been planned, approved, and budgeted in the Shuttle element projects; i.e., Orbiter, Space Shuttle Main Engine, External Tank, Solid Rocket Booster, and

Launch and Landing. This 35-workday generic turnaround capability of the Shuttle vehicle is the basis for current Shuttle manifest planning for FY 85 and subsequent years. This turnaround capability also supports the existing manifest through FY 87 as the KSC launch rate approaches 20 per year in FY 88.

An additional incremental advancement of Shuttle turnaround capability is needed to provide further margins for unique scheduling requirements and for cost savings (efficiency) in the event that higher flight rates are later required. We are now identifying and planning the necessary improvements for the 28-day turnaround—the next incremental advance.

The full 65,000 lb. cargo capability will be demonstrated at KSC in May 1986 with the Galileo Mission. In order to assure adequate performance reserves for this most demanding mission, the Space Shuttle Main Engines will be operated at the 109% power level.

At Vandenberg Air Force Base (VAFB), the Space Transportation System payload capability will increase as certain performance enhancement measures become available. The lighter weight Filament Wound Case (FWC) segments in the Solid Rocket Motors will increase payload delivery capability on the order of 4,600 lbs. The Filament Wound Case will be available for the first Vandenberg flight in October of 1985.

In accordance with our commitments to the Air Force, the 32.000 lb. payload delivery capability will be available at VAFB in the 1990 time frame.

At both KSC and VAFB, the Space Shuttle Main Engine power levels will be held at as low a level as possible in order to maximize engine operating lifetime.

The Space Shuttle Main Engine has completed its initial flight certification for use at full power level, i.e., 109% throttle setting. This will permit the Space Transportation System to meet its maximum payload commitments. However, during the full power level certification testing, certain life design deficiencies were noted.

The full power level configuration deficiencies are primarily in the turbopump lifetimes. These pump lifetimes are too small to allow routine operation at the 109% thrust level. As a result, the high pressure turbopumps exceed our maintenance objectives. These deficiencies do not mean the Space Shuttle Main Engine cannot be used at the full power level condition. In fact, as noted above, the engine is certified to operate at that condition, and the Agency will be able to meet all its payload commitments requiring 109% thrust. The Agency has embarked on a multiphased development and certification program to provide such an improved engine.

An element of this effort will be the consideration of competition to ensure that the Agency takes maximum advantage of all available talent in resolving our engine deficiencies. It should be noted that there is no reason to believe that the current contractors' approach would not be successful. However, based on the criticality of the engines and the length of time we have been pursuing development problems, we believe it is prudent to seek solutions from a fresh viewpoint. This parallel approach to the engine improvement program will provide assurance that our overall improvement goals are achieved.

There are no issues at this time that preclude conducting safe Space Shuttle missions. Concerns have been expressed about the automatic shutdown of the engines during the recent launch sequence. As you are aware, the system operated precisely as designed to ensure the safety of the crew and the vehicle system. There are issues that have a potential impact on assuring flight safety which are currently receiving appropriate management and technical attention. These include: Orbiter structural adequacy, landing gear system loads capability, maintenance of product quality including avoidance of complacency, and payload-to-Orbiter interface.

We have experienced continuing problems with the waste disposal system and the brakes. Currently, we have contracts with three vendors to provide us design concepts for improving or changing the waste management system. Relative to the brakes, we convened an industrial working group to review the safety of the landing gear including the brakes. Although brake problems are being encountered, it was determined that this is not a safety-of-flight problem but is an operational maintenance issue. Engine anomalies have resulted in some delays, such as the one we recently experienced, but, generally, except for the need to increase engine lifetime, the engines have performed magnificently and have done everything we asked of them. A more worrisome problem has been the failure of the Upper Stages, which potentially affect all launch activities above low-Earth orbit. It appears that the problems with the IUS have been identified and corrected and that the IUS will be available to fly TDRS-B in February/March 1985.

We need to keep reminding ourselves that, while the Shuttle is operational, further improvements and refinements are necessary to expand its capabilities and improve its operating characteristics. The Orbiter fleet modifications that are currently underway are: the modifications to OV-103 and -104 to strengthen the wing to sustain greater aerodynamic loads; modifications to OV-099 and -104 to accommodate the Centaur system; incorporation of a fifth Cryo Tank Set in OV-104 (Atlantis) to achieve additional on-orbit stay time for scientific experiments as we did with Columbia on STS-9; instrumentation of the brake system; and installation of an axle saddle to reduce maintenance costs. Modification of the Orbiters was planned so that they would be available in FY 1985 when the mission model increases and for the Centaur missions.

In addition to the above, system improvements under consideration include the Inertial Measurement Unit (IMU), the General Purpose Computer (GPC), and the Redundant Vernier Reaction Control System (RCS) Thrusters.

We have budgeted the necessary funds and manpower to ensure an adequate supply of spares exists based on current projections. In addition, the Structural Spares Program will maintain a satisfactory level of production activity. However, with the delivery of OV-104 now scheduled in April 1985, the production of Orbiters will conclude. As production phases down, logistics management and support of the fleet will become more difficult as the vendors for the 4,800 Flight Hardware Line Replace Units (LRU's) phase down their deliveries of spares. We expect that the profitability of making repairs and maintaining the skills and equipment within their plants to service Orbiter parts will diminish rapidly, resulting in increased Shuttle operations costs to obtain commitments and sustain capabilities necessary for repairs. We are, therefore, evaluating the possibility of establishing a centralized repair and maintenance depot for Orbiter Flight Hardware lien replacement units at KSC, as well as transferring the management responsibility for logistics support to Kennedy as design maturity is achieved and the Space Transportation System becomes fully operational. The new facility will service only the Orbiter since the External Tank, Solid Rocket Motor and Booster, and the Space Shuttle Main Engine have established logistics support.

The External Tank and the Solid Rocket Booster have an ongoing production capability, and their reliance for spares also can rest on their production lines. The Space Shuttle Main Engine production is scheduled to end in 1986, but overhaul and repair is to continue for the foreseeable future. Hence, the Space Shuttle Main Engine Original Equipment Manufacturer (OEM) can be relied upon to logistically support the 209 LRU's in the future. In summary, the present contractors that now perform the depot logistics support for the External Tank, the Solid Rocket Motor, the Solid Rocket Booster, and the Space Shuttle Main Engine can continue to do so as part of their production, refurbishment, or overhaul programs.

A major near-term NASA objective is to establish the framework and policies upon which to base the organization and management structure for future Space Transportation System operations. The experience base and maturity gained since the first Shuttle flight, and the current contractor consolidation efforts at KSC, and now underway at JSC, provide an opportunity to explore new and innovative ideas for future directions of Space Transportation System operations.

We are currently in the process of formulating a task force on Shuttle Operations Strategic Planning to undertake a comprehensive assessment of options for future operation of the National Space Transportation System. The task force will address your request for a preliminary timeable for completion of activities to fence Shuttle operating budgets, facilities, and personnel, as well as organizational design and setting options including consolidation or segregation of Shuttle operations within NASA, possibly preparatory to divestiture and formation within a Government or commercial corporation or other institutional setting.

Mr. Chairman, this concludes my prepared remarks. I would like to introduce the members of my staff who are here at the table with me.

We would be happy to answer any of your questions.

Mr. VOLKMER. Thank you very much, Mr. Moore.

The gentleman from Pennsylvania.

Mr. WALKER. Thank you, Mr. Chairman.

Just so we could—this is kind of a cleanup detail from my questions to Mr. Beggs. Just so we could get some understanding of some of the business of the pricing, could we have you provide for the record some definitions for us that would provide the difference between marginal costs, additive costs, out-of-pocket costs, aggregate costs, full cost and user fees?

[The information follows:]

NASA Cost Definitions

1. Full Cost—full cost (also referred to as full operations cost), is the average operating cost to NASA for Shuttle launches. This includes an average of the total costs for consummable and refurbishable hardware items, such as, external tanks and SRBs, launch operations support, and flight operations support.

2. Aggregate Costs—aggregate costs are the sum of the total operations costs and the use charge. Use charge is a charge, in lieu of depeciation, for use of government facilities and/or equipment

3. User Fees—Synonymous with prices.

4. Additive Cost—all additional costs that NASA has to incur to meet non-U.S. Government customer requirements.

5. Out-of-Pocket Cost—out-of-pocket cost is the average total full cost for consumables plus the additive launch operations and flight operations support costs.

6. Marginal Cost—the cost to launch one more, or drop one flight, against the base level of expenditures required to launch the planned flight rate.

Mr. **Moore**. Yes, sir, we will attempt to provide those definitions. However, I'd like to remind you that maybe everybody's definition is not going to be the same, but we'll tell you what we think we mean by those particular cost elements.

Mr. **Walker**. The reason I think it's important is because I thoroughly agree with what the Administrator said about the amortization of the costs of shuttle through the pricing policies. I don't have a problem with that. That makes sense, good business sense. It makes a logical way of pricing policy.

What a number of us have a problem with is trying to figure out just how all that comes together, that, you know, just what is it we're talking about, where do those lines cross, when are they going to cost, what kind of timeframe are we talking about, and all of that, to—so that we see the pattern where we're going to end up after 25 years with some realistic version of what the Administrator outlines. So it would be helpful to have some of these things so that we would be able to begin to understand the flow of the financial data that we're talking about.

Mr. **Moore**. Mr. Walker, we'll provide those items to you.

Mr. **Walker**. Thank you.

[The information follows:]

1982 DOLLARS ANNUAL AVERAGE COST PER FLIGHT—1985 CONGRESSIONAL BUDGET

	Fiscal year—	
	1984	1985
Hardware and consummables (SRB, ET, propel, crew equipment; orb. H/W, spares)	96.4	77.4
Vehicle processing and flight support manpower (launch and flight ops, R&PM, network sppt, contract admin.)	100.5	74.7
Total	196.9	152.1

Mr. **Walker**. Also, the other thing, could we have some idea of how that projected plan that the Administrator referred to is going to work, how we are going to get to the cost reductions that he talked about, so that, again, we can see where those lines cross?

Mr. **Moore**. Yes, sir. In much of the areas where we're achieving cost savings is in our production contracts and with our hardware manufacturers; and we're on good learning curves at our hardware production facilities. And as we stay on those learning curves and improve those learning curves, we get substantial cost reductions in amount of cost—the amount of funds it takes to produce a single unit.

Mr. WALKER. OK. Now you tell me what—when we're talking about a figure here, what is the figure we're talking about between the difference about—what the customer is now paying and the actual cost of flight? I used 80 million here. That was what I understood that the Administrator to outline. My—the staff tells me they think it's closer to $150 to $200 million.

Mr. MOORE. Well, let me just see if I can give you a little bit of data here, and we may have to provide you some of this detail for the record. But, in terms of the cost per flight, as you well know, it's driven, as Mr. Beggs said, by our learning experience as well as flight rate.

Mr. WALKER. Sure.

Mr. MOORE. From fiscal 1983 to fiscal 1985, we're projecting to have cut the operational cost per flight of a shuttle by about 50 percent. And in the fiscal year 1985 timeframe, that's putting the cost of a flight at about $150 million. Now as we project that out toward the end of this decade, we are hoping to come down to something under $100 million, as Mr. Beggs has indicated, and we haven't finished that evaluation at that point in time.

The pricing period that we're entering into, beginning in fiscal 1986 through fiscal 1988, will have a price of $71 million, I believe, in fiscal 1983 dollars—in 1982 dollars, I'm sorry. So, that differential on that kind of a learning curve is kind of the difference that I think you were referring to earlier, Mr. Walker.

Mr. WALKER. And the costs are also in 1982 dollars.

Mr. MOORE. That's correct. The $150 million I referenced to you is also in fiscal 1982 dollars.

Mr. WALKER. And the difference now that the place where the prices come down thus far, where you are projecting a $150 million price in the 1985 timeframe, those savings that you have achieved so far are the hardware savings that you just referred to?

Mr. MOORE. A combination. Hardware is certainly a large part of it because, as you know, a part of the cost is hardware. However, we have improved substantially in our efficiency relative to doing our flight activities, our flight planning, how long it takes us to put a mission plan together, and so forth, and our overall learning experience with the people in the program have been able to achieve some additiitional efficiency. So it's not

Mr. WALKER. OK. How many——

Mr. MOORE [continuing]. Only hardware.

Mr. WALKER. How many million in each of those?

Mr. MOORE. I'd have to provide that for the record for you to give you that in the fiscal year 1985 timeframe. I can do that.

[The information follows:]

Mr. WALKER. And those are the two areas where we would anticipate having major cost savings between now and 1990 as well?

Mr. MOORE. Yes, sir. And our ability to learn as we do this particular job downstream, and our people gain more and more experience. We are going to find ways to cut corners in our flight planning, in our overall activities leading up to a launch, as well as we're going to achieve increased savings in our hardware as we get more and more experience in producing that hardware.

Mr. **Volkmer**. Would the gentleman yield?

Mr. **Moore**. Those are going to be the principal finders, I think—factors, Mr. Walker, in terms of that cost——

Mr. **Volkmer**. Would the gentleman yield?

Mr. **Walker**. I'd be glad to yield, Mr. Chairman.

Mr. **Volkmer**. In that regard, would the number of flights per year impact also on the cost per flight?

Mr. **Moore**. Yes, sir, the number of flights per year is a significant factor in terms of the cost per flight in that timeframe. The less units you produce, the less learning you're going to get and the less benefits you're going to get from volumes.

Mr. **Walker**. OK. I have——

Mr. **Moore**. So it will have an impact.

Mr. **Walker**. I have one other question then in that regard. And once again I appreciate you, Mr. Chairman, giving me the time.

How many missions is each main engine booster rocket now expected to fly? And in the case of the main engine, at what power level?

Mr. **Moore**. Well, let me start out by talking about the main engine briefly. We are expecting to fly the main engine nominally at 104 percent, or less thrust if the mission—you can get by in flying at a lower thrust level. We're not expecting to fly any more missions than are absolutely required at the 109-percent level.

Mr. **Walker**. How many is that?

Mr. **Moore**. Well, right now, we're certified to fly about 7 or 8 missions at 109 percent on the main engine, on the SSME.

Now, at a lower thrust level, we are doing a cert program up to about 25 to 30 flights per engine, and so our plans are to use the engine, the basic engine, for that long a period of time during the flight plan.

However, as you know, one of the limitations we've had in the engine program has been the pumps, and we look at pump lifetime, and so forth, and change those out as the seconds of life on the pumps exceed our design criteria.

Now in the case of the SRB's, we think the life there is also very long, on the order of 30 or 40 types of flights over the long period of time, and this reusable hardware in the steel case area.

In the case of the filament wound program case, I think that's another question. We have not determined its reusability yet at this point in time, but I think we're expecting a—a lot of reuse in the hardware that we currently have.

Mike Weeks, do you want to add anything to that?

Mr. **Weeks**. No. I think that you've said it pretty well there. As Jesse said, in responding to Mr. Walker's question, there are not many missions that really require the 109 percent. The tough ones are, like Jesse said, Galileo in 1986 and ISPM in 1986. They are heavy. Occasionally, Air Force missions out of Vandenberg are heavy, but there will be a very little use of the 109 percent, I believe, for quite some years.

Mr. **Walker**. Nevertheless, if we get to a full schedule or operation, it will bring down the cost. You are then going to have to have a fairly full schedule of main engine replacement; isn't that logical? And what kind of projected costs do we have on that?

Mr. **Moore**. Well, our operating costs, Mr. Walker, in the outyears—and I don't believe Mr. Beggs said this this morning, but we're going through an evaluation now of cost data base in terms of trying to get prepared for the next pricing policy. But in the outyears, our cost projections are going to take these factors into account. They take into account engine lifetimes, they take into account pump lifetimes, they take into account reusable hardware life, et cetera, in terms of the repair and maintenance. In other words, how often we have to pull an engine off and replace it with a new one, that is certainly one of the elements in this overall cost plan.

Mr. **Walker**. And that is figured in this—the cost plan that is going to bring the per flight cost below $100 million.

Mr. **Moore**. That is absolutely correct. Yes, sir. All of those elements are in there. How often we have to repair, how often we have to make mods and things of this nature are in those particular cost projections that we're targeting for in the latter part of this year—of this century, I should say.

Mr. **Walker**. I, too, want to add my congratulations to you on assuming——

Mr. **Moore**. Thank you very much.

Mr. **Walker**. We look forward to working with you. Thank you.

Mr. **Moore**. Yeah, same here. Thank you.

Mr. **Volkmer**. The gentleman from Florida.

Mr. **MacKay**. I'm interested in your views of the shuttle as a competitive launch system to the Ariane, and possibly the Atlas system later on to be developed. It would seem to me if I were starting to think like a competitor, I would be trying to figure out how to reprice. And, in fact, we had the Air Force officials here and we were talking about the Atlas, and they were saying your pricing decisions were going to have a major impact on their decision.

It sounds to me like, in response to Mr. Walker, we're being driven by some immutable Old Testament accounting laws. And I'm just saying I love to hear that kind of testimony, but it violates what I think everybody in this room understands are the real world considerations. What I want to know is what are you going to do to meet the competition?

Mr. **Moore**. Well, I think, obviously, setting the price in this timeframe, as Mr. Beggs outlined, is certainly going to be one of the elements. I think, also, as you recall, Mr. Beggs indicated that, to date, we had not—he had not seen many decisions that have been absolutely made on the basis of price alone, and I think that'll be another element that will be looked at in terms of as we go downstream and towards the end of this decade in terms of our price.

I think the other thing we have to look at—and I don't want to be totally evasive relative to your question on price-setting, and maybe I'll ask my colleague here, Mr. Gillam, to talk to you a little bit more about it—but I think one of the things we've got to do, Mr. MacKay, is to pursue the exploitation of the shuttle capabilities. I think that clearly is an area that I think the shuttle is much more than competitive. I think we demonstrated in some of the flights that had been done to date, remarkable kind of things that can have broad-reaching benefits in terms of satellite manufacturers in the long terms. And I think, as we proceed in this decade, we're going to see numerous more of those kinds of opportunities.

So I think one of the major thrusts the program has to undertake in the coming years is to exploit those capabilities, and I think that's one of the challenges that I see ahead of us in this whole area.

The area of price is certainly a very large equation, it has many terms in that equation, and where we settle out on that, I think, is going to take an awful lot of dialogue. But in terms of capability, I think, is where the shuttle really will stand up and meet headon the competition in terms of capability.

Mr. Gillam, do you want to add any additional comments to that?

Mr. GILLAM. I just wanted to say that—that, from our point of view, that there are four basic major factors that come into the pricing question. The first of those four factors is that the impact of the decision made on shuttle pricing on ELV's—and by ELV's, I mean both the expendable launch system such as Centaur and Delta, but the ELV's that fly as upper stages in the shuttle. We have to remember that the private sector's made a substantial investment in that, and if NASA inordinately drives the price up, we're denying them the opportunity of recovering that investment.

The second major factor that we have to consider are the initiatives of commercialization. If we drive the prices of shuttle up inordinately, we will have an adverse impact on those materials sciences and other research activities that could lead to commercial activities in space.

A third major factor is our foreign competition and the impact of our price decision on that.

And, finally, the impact of our price decision on the STS budget.

So we have to examine all of those factors and weigh all of those factors and reach those kinds of decisions. Right now, we're at the point of gathering a data base and, once we gather the data base, we will be able to evaluate those factors, and then arrive at what is a proposed pricing policy.

Mr. MACKAY. Will you get to make the pricing decision, or will you make recommendations and be stuck with what somebody else does?

Mr. MOORE. I think that's an open question at this point in time. I think, as I recall, NASA set the shuttle price back during the last time it was set for the fiscal 1986 through 1988 pricing timeframe. I think that's a question that the Administrator's going to have to address. I view my job in this as providing him the cost data base in the discussion of the various options with him, and I can't give you a conclusive yes or no on that at this point in time.

Mr. MACKAY. Do you find that you're having to take into account what is essentially almost like private sector free market pricing considerations? Do you find that to be in any way conflicting with what I think to be your primary role, which is to be our research agency?

Mr. MOORE. No, not in terms——

Mr. MACKAY. Is there any way—any way that pricing considerations will compromise your research mission with NASA?

Mr. MOORE. No, sir. I think the plan that we have accommodates our NASA projections in terms of flights that the NASA programs have planned out through the end of this decade. And I think the capabilities that we have planned for the STS certainly will meet those requirements, and we're working with the NASA users on an equal basis with the other users in terms of understanding their requirements and facilitating their implementation of their research programs.

Mr. MACKAY. In fact, if you were really taking a broad view of the shuttle, I doubt we would have ever gotten into the shuttle if we had not thought we were headed for manned space station type programs. Can you not properly charge part of this cost as a development cost for that program?

Mr. MOORE. That's——

Mr. MACKAY. I mean do you have to roll over and play dead because other people want to get in the business?

Mr. MOORE. Not necessarily. And I think you heard some comments from the Administrator which says he is very strongly motivated to consider a host of factors in terms of coming up with this price. And I think at this point in time, Mr. MacKay, I can't tell you what that price is going to be, because it's going to be a judgment made by the Administrator of NASA. And certainly that factor you just cited will be a strong consideration in this as well.

Mr. MACKAY. If the Air Force gets into expendable launch vehicles—and I understand that they've now got RFP's out which effectively preclude just about everybody but one program from being involved—and if they say we will underwrite the cost of 10 of these vehicles, doesn't that seem to be subsidizing someone who's getting into the commercial business, as long as we are talking about subsidies?

Mr. MOORE. Well, I think, in terms of what the Air Force is looking at there on their two flights per year beginning in 1988, I think, through 1992, obviously one of our concerns on it is that payloads will come off the shuttle to fly on the particular vehicle.

Mr. MACKAY. Which would drive up your operating costs.

Mr. MOORE. Which will in fact—that was my—that was my tieback. As our flight rate goes down, I made the point earlier that our unit cost for the STS is going to go up. I think if you talk about it in terms of two flights per year, if you would say that were to be it, over a 5-year period of time and that's the end of it, that's probably not that major of an impact. However, if that continues or if that rate grows, I think that impact gets larger and larger as our flight rate goes down and, therefore, the unit costs come back up.

Mr. MACKAY. But it puts in business a person who is then going out to your—with your customer list as his shopping——

Mr. MOORE. Yes, sir.

Mr. MACKAY [continuing]. Pad, and is trying to take the rest of your business from you.

Mr. MOORE. Yes, sir.

And I think, as I recall, the program—I think Mr. Aldridge will be here in the morning to talk about the Air Force's plans in this particular area. I think, from the shuttle point of view, as Mr. Beggs said earlier, we value the Department of Defense as a customer on the STS and are doing everything we can to accommodate their requirements, and are working with them to try to meet their requirements.

Mr. MacKay. Thank you, Mr. Chairman.

Mr. Volkmer. Thank you.

I have several questions.

See, this year, we had a projected use of the shuttle of 10 flights, now we're down to 4. Next year we have—and various reasons, of course, not necessarily all connected with the shuttle, partially with the shuttle—next year we have projection of 11. How much slippage are you now anticipating in that 11 for next year?

Mr. Moore. Well, Mr. Chairman, that's a tough question to answer. We are hoping there's no slippage in that 11 flights next year.

As you know, there were some generic problems that happened over the past year and a half in the program that caused some juggling of our manifesting plans in this year, as well as, I believe, the Department of Defense removed two flights from our plans as well.

We had, as you know, the inertial upper stage anomaly that happened on the TDRSS launch in April 1983, and then we most recently had the PAM situation, the upper stage situation, with Westar and Palapa. And that has caused some juggling of cargos. However, we hope that both of those programs are on a path of recovery at this stage in time.

If the customers' payloads are certainly on a program that way, then we expect to meet the 11 flights that we have projected, assuming the payloads meet that particular thing. I see nothing in the way of a shuttle program that is not going to allow us to accommodate those 11 flights in the 1984—or the 1985 timeframe.

Mr. Volkmer. And you see no repeat of what happened on 41D or a similar type?

Mr. Moore. We certainly are not forecasting a repeat of that. Obviously, one can't be absolutely guaranteed, but we think there have been a lot of very prudent steps taken in that situation, and we're looking very hard at the overall abort that happened on 41D, not only in the engine, but also in the general purpose computer, and we're certainly optimistic that we're not going to see that again.

Mr. Volkmer. Where are we—well, why don't you give me, say, by 1988, what would be your most pessimistic view of the number of flights and your most optimistic view of the number of flights in 1988, taking into consideration what still we have to prove out, number of times we can land into KSC, the refurbishment of the solid rocket boosters, the turnaround time on the computer and programming those, and everything else? What would be the most pessimistic, considering we weren't able to do some of those things?

Mr. Moore. Well, let me comment—and then I'll commment on the longer term—let me comment on the near term. We believe the payloads over the next 33 months to 3-year timeframe are pretty firm. They're making payments, they're making active progress payments.

Mr. Volkmer. I'm not—let's assume we have the payloads.

Mr. Moore. I know that. I'm trying to lead up to the point that, as we enter—get beyond that point, things become less clear. And in our current projections, I would say, in a pessimistic sense, the flight rate projections in the 1988-1989 timeframe could be as low as 25 percent lower than what they are projected today.

In an optimistic sense, I would say we would be a few above the projected rate that we're looking at in the 1987, 1988, 1989 timeframe. And in 1987, our plan was 21, 23 in 1988, 24 in 1989. So a few above that rate, if everything materializes in an optimistic sense. I'd say, in a pessimistic sense, I'd see the level going down maybe as low as 25 percent in flight rate.

Mr. Volkmer. So it could go down around 18 then?

Mr. Moore. Eighteen or maybe a little bit lower than that.

Mr. Volkmer. Yes.

Mr. Moore. Fifteen, eighteen, in that particular ballpark.

Mr. Volkmer. How are we as far as projected when we first started on the shuttle—even 2 years ago. Let's just go back even 2 years and look where we were today—3 years. Let's say 1981, see where we are in 1984 and—on turnaround time.

Mr. Moore. Well, I think—let me make a general comment, and then I'll turn it over to my director of shuttle operations, Mr. Gunn, here to comment on it a little bit more difficult—in more detail.

The best we've done to date, Mr. Chairman, on turning around orbiter has been, I believe, 53 days. Our projections within the next year to 2 will be to get down to 35 working days. And in the longer term, over the next 2 or 3 more years, to get down to about 28 days. We see the turnaround time coming down. As our experience is increasing with the orbiters and working with all the elements of the STS system, we see that turnaround time coming down to meet those kind of goals. We believe the capability is being put in place to allow us to meet those goals, and we see real—real progress toward getting down to those kind of turnaround levels.

Let me ask Mr. Gunn if he might want to elaborate a little bit more on some of the specifics relative to turnaround.

Mr. Gunn. When we talk about turning around, we really have to talk about the orbiter that we're using, whether it's the first flight of orbiter or if its been turned around before.

Mr. Volkmer. Well, after next year, we're not going to have a first flight.

Mr. Gunn. Next year, we will have all of our orbiters at least turned around once.

Our present experience is if it—on the first of a kind, it's taking us like 100 days to turn it around in the OPF, in our orbiter processing facility. Now, typically, we're running like 30 to 50 days. The best we've done in the OPF is like 26 days. And to get down to the 35 days, that's our target in the near term, we're going to have to drive that 26 days down to 18.

The processing in the vertical—or the vehicle assembly building, our target there is 4 days, and we've already achieved that. And our target out on the pad is to get that down to around 13. The best we've done out there is 18, so we have quite a bit of work to do there.

But the planning and the facilities and the budget are in place to get our turnaround down to 35 days.

Mr. **Volkmer**. What about the requirements to rewrite and validate the mission computer software? Are we having any problems with timeframe in that?

Mr. **Moore**. Well, Mr. Chairman, the process we're currently using right now on 41D—as you know, 41D, we've moved some cargos from 41F onto 41D and, as a consequence, had to go back and replan and redevelop at least the overall flow for the software on the new 41D.

We have a process that we go through whereby we assign software teams to various flights and, at any given time, we may have five, six or seven teams in place doing flight software planning for upcoming flights. On July 10, when we made this decision to combine these cargos, we had to remove some people from teams that were working on other flight software planning onto the 41D and, as a result of that, we put together cargo tapes for all elements on that.

The process is somewhat mechanical in that we had to go through and work each individual element for a cargo element, and then go back and run the string to make sure it held together from beginning to end. The time required is driven largely by that activity to get to the point where you could put the start to the ending sequence together and the verification of that sequence. In other words, we've gone through a fairly extensive, and are going through a fairly extensive verification process to ensure, one, that the flight software meets the customer requirements, that it plays into the orbiter system, that the crew knows how to interact with it, the ground system knows how to review that, and that's basically the verification activities that are currently planned for 41D and are ongoing.

In the future, in June of next year, we plan to automate. We'll have a system come online with more automated capability in terms of flight software planning. So remanifesting comes up, our turnaround time in the remanifesting and the flight software planning will be substantially shortened. And we think that's going to be absolutely necessary for us as we head in the long term in terms of the kind of flight rates we're looking at right now. So we're looking forward to that capability coming on line in about 9 months to year.

Mr. **Volkmer**. In the next, let's see, 15 to 20 years, without any accident happening, we'll be able to continue to use the four orbiters. They're going to have a minimum of that life span.

Mr. **Moore**. Yes, sir.

Mr. **Volkmer**. Do you anticipate, though, that there may be a need for a fifth orbiter for additional payloads during that time period, with the space station and everything?

Mr. **Moore**. I think that certainly has to be looked at. I think the Administrator's testified before, and my predecessor has testified before that, based on demand, there certainly could be a need for a fifth orbiter, if you look at the demand.

I think, in terms of the—and as you know, we are preserving an option for a fifth orbiter through the structural spares program, as well as the other spares activities that, with your committee's support, we've been able to implement the program. So we are essentially preserving an option.

I think, in terms of the demand, it's clearly looking into the crystal ball. And I think the space station is obviously going to add some demand to the program. We hope the communications satellites is going to get out of its "glut period" that Mr. Beggs cited earlier, and back on a high demand basis. And I would hope some of our commercialization initiatives are going to begin to really build a market out there, because I think that's what's going to create the demand for launches and flights. I think it's the products that we can produce and manufacture in space that—where the real market potential is, and we need to make sure that everything is done to foster those markets. So as the products get more and more developed, we do more and more things in space, obviously the launch demand is going to go up. And I think the product in—of the space business is something that I think we need to give very strong attention to in the future. And I think if these kind of things come about, yes, I could see the need for a fifth orbiter, Mr. Chairman.

Mr. VOLKMER. The things that concern I think us, and I'm sure it concerns those of you in NASA also is, if we're going to do the fifth orbiter, where is going to be the production facilities if we wait too long to make that decision; is that correct? That is a concern also?

Mr. MOORE. I think that we obviously are reaching a point in our program where the structural spares will carry us through about 1986 and into early 1987 to finish off the structural elements that we initiated back, I believe, in fiscal 1984. Other spare hardware activities in some of our second- and third-tier vendors are beginning to phase down in the latter part of 1985 and 1986. And I think, you know, it depends on when you make that judgment to go forward with the fifth orbiter.

Let me just parenthetically state that, internally as we formulate our plans for fiscal 1986, we are obviously giving consideration to a fifth orbiter. But as the program phases down in terms of the requirements for some of the second- and third-tier, and even some of the prime vendors, the opportunity to capitalize on some of the investments in economies that exist in those areas, certainly it diminishes.

However, I don't think that you could state that you would stop totally the capability to build another orbiter. I think it would cost you more. It would be inefficient. You'd have to maybe go back, qualify second sources and things of this nature for parts, and so forth. But I think you could pick up downstream if the country's demand or desire was to do that.

I think, from an efficiency point of view, one is looking at a time in the program now as we move forward toward the end of our structural spares and the other spares in the program where one will have to give very serious consideration to doing it in the very new future. Otherwise the lack of an economic tie will cause you to pay a much higher price, I think, for an additional orbiter.

Mr. VOLKMER. Now, earlier, the gentleman from Pennsylvania was discussing in quite detail the cost factor on use of the space shuttle. And I had asked a question as to the factor as the number of flights per year entered into it, and correctly they do. Is there—can you give me an idea as to the correlation of elasticity what I would call in regard to the number of flights as to the—how it impacts on the cost per flight.

Mr. **Moore**. I think Mr. Chairman, I'm simply prepared to discuss that today in generic terms. I think we can supply you some additional data for the record, if that would be acceptable to you.

Mr. **Volkmer**. Yes, because we will have additional questions also in writing. And, by the way, I would like to hold the record open for 2 weeks so we have the questions. We will have some for Mr. Beggs, too.

[The information follows:]

For each unit of reduction in the flight rate, at 24 flights per year, the increase in cost per flight maintains almost a constant one to one percentage relationship.

Fiscal year 1989 (24/yr) flight reduction	*Approximate percent change in CPF*
−1	3
−2	6
−4	12
−8	27

Mr. **Volkmer**. But I would like to have some idea on that, because I'm sure it's just not——

Mr. **Moore**. Yes, sir.

Mr. **Volkmer** [continuing]. A strict percentage. I'm sure there's some elasticity in it.

Mr. **Moore**. Absolutely.

Mr. **Volkmer**. Earlier when Mr. Beggs was here, I did ask in regard to the problem with logistics, and I would like for you to address that, if you would, and what are we doing in order to resolve that? And after that, then I have one other question in regard to logistics I'd like to address.

Mr. **Moore**. Mr. Gunn, you're—you're are—I'll ask Mr. Gunn——

Mr. **Volkmer**. Fine.

Mr. **Moore** [continuing]. Who's our logistics man.

Mr. **Gunn**. As you know, with——

Mr. **Volkmer**. I'd appreciate it if you'd pull that a little closer because you have to almost speak right into it.

Mr. **Gunn**. With the support of your committee and Congress to recognize the severity of our spares problems, and the Congress approved a substantial increase in our spares for the orbiter and the engine in our 1985 budget—and indeed, in our 1985 budget, roughly one-sixth of the shuttle operations budget is for logistics support, principally orbiter spares and engine spares. And that budget, of course, includes the structural spares for the orbiter and a number of spare—extra spare engines for the orbiter.

However, the lead time between getting a budget and getting some spares on the shuttle runs a minimum of 2 to 3 years and, therefore, we expect that we're going to continue to have our spare shortage through 1985 and 1986. We are sensitized to the need to increase our lay-in of spares. I believe that, with the current emphasis and attention that we have to shuttle logistics, that we now have the adequate manpower within NASA and our contractors to bring on the spares on time. And we have in place, I believe, the policies and the procedures and procurement planning to lay in the spares at a rate that will support the mission model.

There's been some question of cannibalization, using the orbiter as a vehicle to provide spares in the past. I'd like to give you some data from a recent experience. At Kennedy, during the months of April, May, and June, our requisite fill rates have ranged from 80—from 93 percent to 95 percent. And what that means is that, when you go to the shelf to take a spare, between 93 and 95 percent of the time, that spare's on the shelf and available for use. That's for all of the shuttle spares. If you break out just the orbiter by itself, our experience is not quite as good. It averaged 75 percent in April, and it was up to 83 percent in June. So we are continuing to improve, but we still have a far ways to go until we get 100 percent.

We're going to continue to experience shortages on our turbo pumps, our nozzles and our controllers on the engine, because they are also long-lead items, but I think by 1986, we'll have that well in hand.

So I think, in summary, our cannibalization experience has been fairly low and we're keeping it there. We recognize the severity and the magnitude of our problem, and we have an aggressive program that's underway, and I think it's going to pay of in a couple of years. And we're confident we have a plan that will support the flight rate in our spares program.

Mr. **Volkmer**. At the present time, as far as logistics responsibility, is that not centered both at Johnson and Marshall——

the cape and JSC in terms of transitioning a lot of those kinds of functions.

I think that same type of dialogue is going to exist in this period of time over the SRB. As you know, we're in the process of recompeting the refurbishment of those SRB's and have initiated a facility at the Kennedy Space Center to do that refurbishment of the SRB's, so that will take place.

In the area of the engine, I think—in those areas where we see some production capability continuing, we've got spares and logistics through the original equipment manufacturer. And that part of the program will be discussed to make determinations on those items, how fast and rapidly we can consolidate those kinds of things under a singular management project KSC.

Mr. Volkmer. All right.

To continue on with the thought, since we are moving to private contractor operations support, is there any possibility in the future that the spare parts and logistics, et cetera, would be handled by a contractor?

Mr. Moore. I think——

Mr. Volkmer. There's that possibility?

Mr. Moore. I think there's that possibility. Yes, sir, I'd have to admit there is certainly that possibility.

We do not have any specific plans in hand that would cite that as being anything that were planning to implement in the near term. I think, as we proceed to implement our overall program logistics policy, those types of things will be looked at, and will be looked at principally in the interest of further cutting the operational costs and how much funding it's going to require to keep the orbiter fleet sustained on the kind of flight basis that we're looking at.

Mr. Volkmer. All right.

Mr. Gunn, I would like to get back to the spare parts, especially to the engines.

Approximately in what timeframe can we envision that we will have available a spare engine for each shuttle, one of the four? How long is it going to be before——

Mr. Dankhoff. Well——

Mr. Moore. Mr. Dankhoff here from my office, who heads up the propulsion division on the shuttle.

Mr. Dankhoff. The position we're in right now is we do have one spare engine and, as you know, we are operating two orbiters and one is in Palmdale. We will be in a position of another spare engine by the first of this year and, by the end of next year, we will have a spare engine for each of the four orbiters.

Mr. Volkmer. So we're looking at—are we talking fiscal year when you say next year, or are we talking calendar year?

Mr. Moore. I think we're talking the end of calendar year. By the end of 1985——

Mr. Volkmer. By 1985.

Mr. Moore [continuing]. Sir, I expect to have a pristine spare, which is our objective, for the four orbiters that we have in the fleet.

Mr. Volkmer. All right.

Now as we move into reduced timeframes for turnaround and reducing operating costs, are we not also continuing to look at the question of quality control and flight safety?

Mr. MOORE. Yes, sir. I think those have certainly got to be of paramount importance to this program as we move downstream. I think maintaining quality is something that all of us have to have very high in the priority list of things to do. We have to work with our centers to ensure that quality is a—is a clear primary objective. We have to encourage the entire STS team and our contracting team to ensure that quality is of paramount importance.

I think we made a lot of good progress over the past couple of years in the quality area. And I think that's due to the fact that we are paying a lot of attention to quality. And we are continuing to be concerned about those areas that could impact flight safety or jeopardize flight safety. And, as I said in my opening remarks, I think flight safety is—has got to be the primary thing that the space shuttle program goes after. Quality is part of flight safety and maintaining flight safety.

And as you do things more and more on a routine basis, there is certainly a tendency to become more complacent. It's easier to do and not be as sensitive and as acute to a quality flaw. And I think all of us have to recognize that, and that has to be of paramount importance in the whole STS team's mentality as we go downstream.

Mr. VOLKMER. In other words, the safety factor is paramount over turnaround time then?

Mr. MOORE. Yes, sir.

Mr. VOLKMER. OK.

Mr. MOORE. Flight safety is my primary objective to make sure that we're safe. And we want to achieve our other goals within the envelope set by maintaining a safe mission for us in the shuttle program.

Mr. VOLKMER. All right.

[Answers to written questions for Mr. Moore follow:]

Questions submitted by Chairman Volkmer during the July 31, 1984, hearing at which Mr. Moore testified on Shuttle operations.

QUESTION M-1:

What internal STS management changes are expected within NASA in the next 5 to 10 years?

ANSWER M-1:

A major NASA objective is to establish the framework and policies upon which to base the organization and management structure for future STS operations. The experience base and maturity gained since the first Shuttle flight, and the current contractor consolidation efforts at KSC and JSC, provide a solid baseline from which to explore new and innovative ideas for future directions of STS operations.

We expect to continue exploring STS management changes. At the present time, we are considering consolidating logistics management responsibility at the Kennedy Space Center. Other changes will evolve from the work of the Strategic Planning Group and the Task Force we have set up within the Office of Space Flight to look at possible milestones for fencing Shuttle operations.

QUESTION M-2:

What trends are expected in NASA and contractor personnel requirements to support the Space Shuttle program over the next 5 to 10 years?

ANSWER M-2:

JSC is seeking an STS Operations Contract (STSOC) contractor to bring cost effective approaches to mission operations during the STS operations era while maintaining a high level of technical performance. The conditions to be described in the RFP will present offerors considerable latitude in forming and developing an approach based on their unique capabilities and experiences. The STS basic program objective of reliable and economical space transportation is paramount; conformance with the historical "business-as-usual" approach, typical of development and test programs, is not. Offerors will be encouraged to consider an overall management offering, where applicable and effective, new and innovative management techniques as a basis for developing their proposals. NASA recognizes the importance of its role to the overall success of a new management approach and will tailor its participation to the mutual fulfillment of STS program objectives. This approach should result in a substantial saving in both Contractor and Civil Servant personnel.

The Kennedy Space Center has entered into two major operations contracts that are geared toward reducing costs and improving efficiency in the areas of base operations and Shuttle processing. The first of these efforts, the Base Operations Contract, was given to EG&G in November 1982. This contract is for providing overall base support functions for the routine day-to-day operations of

KSC. The second effort, the Shuttle Processing Contract, was awarded to Lockheed in September 1983. The objective of this contract is to provide adequate and reliable processing of the Shuttle hardware elements, plus integration, launch and recovery of the vehicle. Both of these contracts are progressing successfully with significant savings. Future consideration is being given to consolidating cargo processing operations into a consolidated contract.

QUESTION M-3:

What factors currently most constrain Space Shuttle launch rate? What are NASA's plans for correcting these constraints?

ANSWER M-3:

Certain specific launch processing facilities or work stations are the principal current constraints to reach a launch rate of about 20 per year at KSC. These, in order of constraint, are the number of mobile launch platforms (MLPs), launch pads and possibly Orbiter processing facility (OPF) bays. Fourth and fifth order constraints are the availability of Orbiters and Orbiter turnaround time.

At JSC, the capability of the mission support activities and facilities could constrain that Center's capability. These activities and facilities include the Mission Control Center, Flight Design crew activity planning, Software Production Facility, Flight Control, Shuttle Mission Simulators and Shuttle Training Aircraft.

At KSC a third MLP and a second launch pad are under construction and on schedule for operational readiness on 9-30-86 and 1-1 86, respectively. The pad is needed first to meet an early dual launch pad requirement. The possible need for an Orbiter bay is now being evaluated. Availability of the Orbiters will be improved after current modifications are finished and the fourth Orbiter is delivered early next year. Orbiter turnaround improvements are being identified and defined now for implementation later when required. Current facilities and Orbiter capabilities can meet current manifest needs.

At JSC, all aspects of mission support have had, or now have, undergone significant levels of effort directed toward keeping pace with the increasing flight rate (up to a maximum of 24 per year). These efforts range in form from simply adding capacity, working more efficiently, increasing parallel activity, to shortening the reconfiguration time from flight to flight. Whenever possible, the modifications are also productivity improvements so that increased workloads can be handled for less cost and/or reduced manpower levels. This process still has some distance to go and the required funding is reflected in NASA's budget plans.

QUESTION M-4:

How have actual Orbiter turnaround times compared with original goals?

ANSWER M-4:

The Orbiter turnaround design target was originally two weeks or 10 days at two shifts per day; however, this target was not achieved. It had to be traded off in favor of flight performance and safety parameters. Since each new Orbiter has had various modifications and the first flows are not turnaround flows, per se, turnaround times for each Orbiter have begun with long periods of over 100 workdays and improved during recycles to as low as 53 workdays for OV-099 on STS 41-C. NASA expects to demonstrate the Orbiter turnaround goal of 35 workdays during this coming fiscal year (FY85). We are also identifying Orbiter improvement for later implementation to reduce the turnaround time to 28 workdays.

QUESTION M-5:

What is the likelihood that the Space Shuttle fleet will have to be expanded to six or more Orbiters at any time during the next 10 to 15 years?

ANSWER M-5:

NASA's projected mission model, over the next approximately 10 years, peaks at 24 flights per year. The current four Orbiter fleet can meet that launch rate. If new requirements arise beyond that which is now projected, then the need for additional Orbiters would be re-examined.

QUESTION M-6:

What is Orbiter lifetime likely to be (100, 200, 500 flights)?

ANSWER M-6:

The Orbiter vehicle has been designed to be capable of 100 flights. However, all major load carrying structures are designed to be capable of surviving without failure, a total number of flights four times greater (400 flights). Some subsystems are limited to less than 100 flights, however, spares are provided as required to support the mission model.

QUESTION M-7:

a. Over the next 15 to 20 years, how many new Orbiters will likely be required as "replenishment" vehicles to replace worn out Orbiters in the current fleet?

b. If replenishment/replacement Orbiters will be required, what provisions will be made to keep the necessary contractor support available so that they can be built?

c. What will be the approximate annual cost of keeping the necessary contractor support available?

ANSWER M-7:

a. Based upon a projected peak flight rate of 24 flights per year, (the current NASA manifest peaks at this rate) and a fleet of four Orbiters, the Orbiters now in service will meet the 100 mission design goal in approximately 15 to 20 years and replenishment Orbiters would be required. However, this does not take into account any inspection and overhaul program that could possibly extend the lifetimes of the Orbiter vehicles. The number of replenishment vehicles would depend on many factors that are not predictable with any accuracy today. These are factors, such as, flight rate, mission requirements, national goals, etc.

b. Current NASA planning does not include provisions to keep the contractor support base available to produce "replenishment" Orbiters 15 to 20 years in the future. We will maintain repair services, engineering support, and logistical support for the current fleet. NASA's assessment is that Orbiters produced in that time frame could be significantly different from today's Orbiter, as new technologies and processes would then be available.

c. Keeping the necessary contractor support available to build replenishment Orbiters would cost approximately $400M annually.

QUESTION M-8:

How closely have Space Shuttle Operating Costs tracked original estimates?

ANSWER M-8:

Original estimates of Space Shuttle Operating Costs are contained in the June, 1976 User Charge Data Base, which was developed to support initial Shuttle pricing policy. At that time, operations costs were averaged over a twelve year period containing 572 flights, with a peak sustained flight rate of 60 per year. The resultant average cost per flight was then estimated at $18.0M (FY 1975$). Operations costs supporting the FY 1985 Congressional Budget, when extended to encompass a comparable twelve year period, results in an average of $59.7M (FY 1975 $) for 227 flights at a maximum sustained flight rate of 24 per year.

One of the key reasons for this large increase in average cost per flight is the fact that, with the higher flight rate and earlier program operational capability predicted in the June 1976 User Charge Data Base, the total number of flights in the FY 1985 Congressional Budget runout (through FY 1989) would have been flown by mid-FY 1984; the total 227 flights contained in the FY 1985 Congressional Budget cost-per-flight estimate (12 year average) would have covered only 6 1/2 years. Additionally, there have been significant changes in the scope and estimated cost of Shuttle Operations. These include better definition of life-limited hardware requirements based on actual flight experience; configuration changes to accommodate a better understanding of the Shuttle vibro-acoustic environment (thermal protection, ice/debris protection, structures, range safety, etc.,); better understanding of spares and operational engineering/logistics requirements; increased cost of consumables/expendables due to improved configurations, market factors, schedule slippage and loss of economics due to lower quantities; better definition of turnaround, reuse, reconfiguration (hardware and software), and other key drivers that influence operational costs; and the general upgrading of NASA's ability to accurately predict overall costs now that the operational program is fully underway, and the experience base is available for analysis.

QUESTION M-9:

How sensitive are "additive" Space Shuttle operating costs to variations in launch rate.

In the short term?
In the long term?

ANSWER M-9:

"Additive" or more precisely marginal cost is assumed to represent the unit value assignable to the "last unit" added in a given fiscal year and is therefore heavily influenced by variable costs. Shuttle operations variable costs are dependant upon the particular project involved. The flight hardware projects tend to have high variable costs while the manpower intensive projects, launch and flight operations, tend to have relatively high fixed base costs.

Short term fluctuations in the launch rate do not allow for changes or a rebalancing in the fixed base. A reduction in launch rate over a longer term provides an opportunity to adjust the fixed base to a lower level of activity to the extent possible.

QUESTION M-10:

Should Space Shuttle launch rates turn out to be less than currently projected, what would the impact of this be on the Shuttle program and its operating costs?

ANSWER M-10:

If the demand for Shuttle flights is less than anticipated, NASA would reduce flight requirements and thereby total operating costs. The cost to the government would depend upon whether flights were commercial flights. If the reduction were commercial, the cost to the government, under the current pricing policy, would increase by the difference between the current $71M price (FY82$) and the estimated marginal cost. NASA believes this differenc is on the order of $30M (FY82$) per flight.

QUESTION M-11:

a. What improvements in Orbiter capability (e.g., on orbit stay time, available maneuver propellant, electrical power, etc.) are currently planned?

b. What other improvements are likely over the next 10 to 15 years?

ANSWER M-11:

a. Improvements currently planned or being evaluated are primarily aimed at enhancements of current systems, rather than large scale improvements in capabilities, such as on-orbit stay time, electrical power, etc., which would require substantial cost and time.

Some current improvements/modifications that are being implemented include strengthening of the wings on OV-103 and OV-104 to sustain greater aerodynamic loads, incorporation of Centaur modifications into OV-099 and OV-104. We are also making improvements to the Orbiter brakes and the APU system. We are also looking at an improved General Purpose Computer, an improved Mass Memory, an upgraded Star Tracker, among other systems.

b. Over the next 10 to 15 years, we may move to improvements of the nature that will extend overall Orbiter capability. These could be areas such as increased electrical capacity through solar array or battery techniques, increased consumables to lengthen the on-orbit stay time through regenerative CO_2 techniques and other such improvements.

QUESTION M-12:

What level of continuing R&D activity is likely to be required in support of the Space Shuttle program over the next decade?

ANSWER 12:

The predominent R&D activity identified to continue over the next decade in support of Shuttle is that residual development required for the Main Engine to improve component life, increase reliability and reduce the heretofore high maintenance costs. Other R&D activity that is planned to be completed in the first half of the next decade includes some residual development for the Solid Rocket Booster and External Tank in order to reduce operating costs and also development of a booster modification to improve performance for launches out of the Vandenberg Launch Site.

QUESTION 13:

a. What modifications in flight hardware will be required to meet the 32,000 pound payload delivery capability from Vandenberg?

b. Why will this capability not be available before 1990?

c. Does DOD or NASA have any need for this capability before 1990?

ANSWER 13:

The improvements in flight hardware which will be implemented for VAFB flights of the STS, that is, the use of lighter weight Filament Wound Case segments in the Solid Rocket Motors and the higher thrust level operation of the SSME's, will be available for flight as early as 1987. The additional performance capability which will be required to reach the 32,000 lbs. payload level will be on the order of several thousands of pounds. That additional capability will be attained through the experience gained during STS flight operations at Vandenberg and, if necessary, by the demanifesting of certain orbiter equipment not required for a particular flight.

The 1990 availability for the full 32,000 lbs. payload capability is predicted upon the earliest projected DOD requirement for that capability and on the realization that those performance improvement factors which will accrue from actual flight experience will be based upon analyses of the results of flying the various different types of trajectories and orbital parameters associated with each of the earlier VAFB flights.

Neither the DOD nor NASA has any need for the full 32,000 lbs. payload capability at Vandenberg before the 1990 time.

QUESTION M-14:

By how much are Space Shuttle payload lift requirements likely to grow beyond current design requirements during the next 10 to 15 years?

ANSWER M-14:

Historically, payloads designed for expendable launch on vehicles such as Delta and Atlas/Centaur have grown to fill whatever capacity was provided by the vehicle as it matured. In some cases, such as Intelsat, the payload outgrew the smaller expendable vehicle in favor of the larger, namely, Atlas/Centaur for Delta.

Already in the short history of the Space Shuttle, we have seen a growth in payload requirements that have stimulated the development of the PAM-D2, an expanded version of the initially developed PAM-D.

A near-term (5 to 10 years) growth factor of twenty five (25) percent is not uncommon for any class of payload - PAM-D being one class, Inertial Upper Stage another class, and Centaur a third class. If history were to repeat, one could expect a payload growth rate of about three (3) percent per year within any class of customer. In fifteen years, therefore, a payload growth factor of approximately 55 percent can be expected. The majority of commercial customers are now in the PAM class and they have the potential to have most of their growth requirements handled by going to the higher classes of upper stages rather than depending upon improvements in the Shuttle system.

However, there is a school of thought that says that communication satellites have about reached their maximum cost/lb attractiveness and that there are some advantages beginning to appear for smaller, less expensive but multiple comsats.

QUESTION M-15:

What major logistics issues must be resolved over the next 5 to 10 years?

ANSWER M-15:

The two major logistics issues which must be resolved within the next few years are:

1. The extent of NASA involvement in the logistics support program. Do we try to approach self-sufficiency with minimum DOD/Contractor involvement or do we completely turn support over to a Shuttle processing contractor. Do we build a maintenance/repair depot at KSC or contract for this capability.

2. Another problem will be how to sustain economical contractor support for low failure line replaceable units, shop replaceable units, and piece parts for the life of the Shuttle program. Do we greatly expand our in-house support/repair capability or selectively pay to keep contractors in stand-by status.

QUESTION M-16:

a. How adequately will the Space Shuttle be able to meet user needs over the next 10 to 15 years?

b. What user requirements or desires are likely to be unfulfilled during the next 10 to 15 years?

ANSWER M-16:

a. We believe that the Space Shuttle will be able to meet user needs over the next 10 to 15 years baring a catastrophic loss of an orbiter. Analytical and demonstrated performance evolve as the program develops and matures. Weight reduction and operational procedures and these enhancements will continue in order to support our stated goals for the 1990's.

b. Currently, all of the manifested and planned requirements can be met. The overall system effectiveness is steadily improving as we demonstrate the new and unique capabilities as exemplified by the retrieval and repair of the SMM spacecraft. However, should the new materials processing products industry develop, the current orbiter fleet alone might be hard pressed to meet the demand in the late 1990's.

QUESTION M-17:

What modifications in Shuttle hardware or procedures are planned to ease the requirements or delivery time-lines that are now levied on users?

ANSWER M-17:

Steps are underway at JSC to substantially reduce the customer's mission integration time, cost, and complexity. The mission integration/flight production process which formerly required about 36 months has now been reduced to about a 22 month cycle. Additional improvements in the efficiency of this process should result in continued compression of the process as the program matures and more repeat payloads are flown.

Documentation requirements are being simplified and streamlined, and redundancy is being eliminated. Also, the review process has been consolidated, resulting in fewer iterations and revisions of mission documentation.

A Customer Services Center has been established at JSC to assist customers in obtaining necessary STS documentation, respond to customer inquiries, and coordinate studies and efforts to further simplify/consolidate the integration process.

Studies are also underway to define the system or hardware to provide rapid turnaround of payload command and data system software. This system will improve cargo integration, reconfiguration and turnaround time from mission to mission, and will facilitate late payload selection and/or changeout.

From a STS cargo processing standpoint, there are a number of enhancements planned that will lead to shortened work flow timelines.

Our customers are encouraged to qualify payloads for flight ready storage in order to minimize pre-launch time at the launch site. They are also urged to provide adequate personnel at the launch site to facilitate multiple shift work as required, so as to minimize actual day staytime.

On a payload-by-payload basis, technical assessments are conducted to determine whether stand-alone, simulated mission sequence, or end-to-end testing can be eliminated.

On-line testing requirements are reviewed to see if such tests as preconnect tests of Orbiter/pad interfaces, mission sequence tests, or end-to-end tests can be deleted.

A continuing effort is underway to identify ways to simplify the payload-to-Orbiter interfaces. As interfaces are simplified, payload installation and subsequent check-out procedures will be streamlined, resulting in time savings.

QUESTION M-18:

The NASA budget contains amounts for STS operations and R&PM manpower. What percentage of the R&PM manpower at the various centers is actually used in support of the STS program, and how is this cost allocated to the cost per flight?

ANSWER M-18:

The R&PM costs included in cost per flight consists of five components - civil service manpower working directly in Operations, travel related to Operations, and a pro rata share of indirect manpower, utilities, support service contractors, and purchased goods and services.

The percentage of civil service manpower at the Office of Space Flight planned for Centers Operations is approximately 35 percent in FY 1985, 30 percent in FY 1986, and 30 percent in FY 1987. .

QUESTION M-19:

How are optional services included in the Shuttle price?

ANSWER M-19:

The basic Shuttle price to the customer covers only specifically defined standard mission services. These services currently include launch from the Eastern Test Range (ETR) into two standard orbits: 160NM/28.5 degrees inclination and 160NM/57.0 degrees inclination, payload installation in the cargo bay, one-day mission operations with a four-man flight crew, on-orbit payload handling, deployment of a payload from the cargo bay, data transmission from the payload to ground receiving stations, Orbiter flight planning services, NASA support of payload design reviews, and NASA payload safety reviews.

Optional or special services are also available, at cost, to the customer. These services include launch from the Western Test Range (WTR), use of upper stages and Spacelab, mission kits to extend basic Orbiter capability, delivery to non-standard orbits, additional time on orbit, crew extra-vehicular activity, and unique mission planning or integration. For communications satellites these are on the order of $1.0 - $1.5 million.

QUESTION M-20:

If the Shuttle pricing policy is revised to require full cost reimbursement, what would be the resulting NASA charge for Delta PAM-D and Atlas Centaur class payloads?

ANSWER M-20:

Customers having payloads such as Delta PAM-D and Atlas Centaur which require less than the full Shuttle are charged according to the fraction of the orbiter cargo bay capability (weight or length) required by the payload. In addition, they typically require an upper stage and optional services including payload processing at KSC. The upper stages and optional service costs are not affected by change to the Shuttle pricing policy.

Under the current Shuttle pricing policy the shared Shuttle price is calculated as follows:

1. Calculate Load Factor

Weight load factor = Payload weight/65,000 lbs.

Length load factor = Payload length/60 ft.

The payload weight to be used is the projected weight of all payload related equipment and required flight kits to be placed aboard the Shuttle, excluding NASA provided payload attach fittings.

The payload length to be used is the projected length along the Shuttle centerline of the dynamic envelope of all payload related equipment and flight kits to be placed in the Shuttle cargo bay, plus any required deployment and access clearances.

The greater of the weight or length load factor is the load factor used for price calculation, with a minimum of 0.05 and a maximum of 0.75.

2. Calculate Charge Factor

Charge Factor = Load Factor X 4/3

3. Calculate the Shared Shuttle Price

The shared Shuttle price is calculated by multiplying the charge factor by the dedicated Shuttle price.

NASA is currently in the process of setting the price for post 1988 launches. The cost of the Shuttle portion of the customer's total cost will change accordingly. The optional services and upper stage costs would not be affected.

QUESTION M-21:

Is there any commercial interest in operating the Shuttle at anything less than full cost reimbursement?

ANSWER M-21:

We do not know if there is any commercial interest in operating the Shuttle at anything less than full cost reimbursement. However, there are precedents for operations of this sort; for example, the railroads. There is a clear interest by many commercial users to maintain a price at less than full cost reimbursement. However, potential suppliers of competing capabilities would like the U.S. Government to charge full costs.

QUESTION M-22:

What will be the total average cost for a Shuttle flight in FY 1985 and FY 1986?

ANSWER M-22:

The 1985 projected average cost per flight in 1982 dollars, for FY 1985 and FY 1986 is $152 million and $123 million respectively, based on 11 flights in 1985 and 16 flights in 1986.

QUESTION M-23:

What will be the marginal cost for a Shuttle flight in FY 1985 and FY 1986?

ANSWER M-23:

The projected marginal cost for a flight in FY 1985 and FY 1986 in FY 1982 dollars is approximately $43 million and $40 million respectively.

QUESTION M-24:

Are all the costs of NASA expenditures and manpower efforts on behalf of the Shuttle being reflected in the price?

ANSWER M-24:

The price for Shuttle launches in Fiscal Years (FY's) 1983, 1984, and 1985 was published by NASA in 1977. This policy was based on the principle that the Government should recover its total for aggregate costs over the 12-year operating horizon and that NASA would charge a fixed, flat rate price for the first three years based on the 12-year average cost to enhance transition to the Shuttle.

In 1982 the decision was made to adopt a three year Phase II pricing policy for launches in FY 1986-1988, based on three year average out of pocket cost. Under this pricing policy all the costs of NASA expenditures and manpower efforts on behalf of the Shuttle for commercial and foreign customers are reflected in the price charged to those customers.

QUESTION M-25:

Was the Shuttle fleet and facilities sized originally to include government users (NASA, DOD, etc.) or to also include commercial users?

ANSWER M-25:

The Space Shuttle was developed as the prime vehicle of a transportation system designed to give the United States (NASA, DOD, other civil Government, and commercial users) and cooperating nations the capability for routine access to space.

QUESTION M-26:

How much profit (or loss) does the government make, considering all applicable costs such as marketing, astronaut training, customers services, etc., from the launch of a commercial communications satellite?

ANSWER M-26:

Under the current pricing policy for launches in FY 1986-1988, commercial and foreign customers of the Shuttle are charged a price based on the average total cost per flight for consumables (hardware items such as external tank, solid rocket boosters, etc.) plus the additive cost of launch operations and flight operations. This policy results in the commercial and foreign customers of the Shuttle paying not only the cost incurred by the Government for their launches but also in making a contribution to the base cost for launching the required U.S. Government launches. For example, a conservative estimate of the current marginal cost of Shuttle flight is $43 million, as compared to the price of $71 million (FY 1982 $) for a dedicated launch. This lowers the cost that the U.S. taxpayer has to pay for the U.S. Government launches of Shuttle.

A commercial communications satellite requires less than the full Shuttle and is charged according to the fraction of the orbiter cargo bay capability (weight or length) which it requires.

QUESTION M-27:

What does NASA now charge for Delta launches in FY75 dollars?

ANSWER M-27:

The full cost to a customer for launching a Delta Model 3920 in 1984, expressed in FY 1975 dollars, is $17.7M. This model Delta is capable of carrying 2,800 lbs to a geostationery synchronous transfer orbit desired by communication satellite customers.

QUESTION M-28:

Has the White House Industry Task Force on Space Commercialization officially issued a final report? If so, when? Have all of the members of this Task Force seen and endorsed the report?

ANSWER M-28:

We understand that a final report has not been issued.

I have no futher questions, and I want to thank you very much, Mr. Moore, and, again, congratulate you Jesse, on the appointment. I wish to thank also Mike Weeks—it's good to see you again—and Mr. Gillam and Mr. Gunn for being here today. I appreciate your spending a good part of your lunch hour with us.

Mr. **Moore**. Thank you, Mr. Chairman.

Mr. **Volkmer**. Thank you very much.

[Whereupon, at 12:25 p.m., the subcommittee was adjourned.]

SPACE SHUTTLE REQUIREMENTS, OPERATIONS, AND FUTURE PLANS

WEDNESDAY, AUGUST 1, 1984

House of Representatives,
Committee on Science and Technology
Subcommittee on Space Science and Applications,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:36 a.m., in room 2325, Rayburn House Office Building, Hon. Harold L. Volkmer (chairman of the subcommittee) presiding.

Present: Representatives Volkmer, Nelson, Andrews, Brown, MacKay, Lowery, Chandler, Bateman, Winn, and Walker.

Mr. Volkmer. The Subcommittee on Space Science and Applications will come to order.

Today, the subcommittee convenes the second of 3 days of hearings to review the status, policies, and trends related to the management and operational use of the space shuttle.

To date, the United States has invested over $20 billion to develop the shuttle and the infrastructure necessary to operate it. This effort has established a national resource that will enable us to exploit space for both public and private good. The extent to which we take advantage of this resource, however, will depend on the development activities, operating policies, and future plans we establish for the space transportation system.

These hearings will provide us with the information we need to make sound decisions on these important matters. At yesterday's hearing, NASA Administrator James Beggs, and other NASA headquarters officials provided valuable insight into the issues confronting the shuttle and our future direction in space. I hope that our witnesses today will be equally responsive.

Our first witness, representing the Department of Defense, a principal user of the shuttle, will be the Under Secretary of the Air Force, the Honorable Edward C. Aldridge, Jr. Secretary Aldridge will be followed by a panel comprising directors of NASA field centers involved in the shuttle program. These witnesses include Gerald Griffin from the Johnson Space Center, William Lucas from the Marshall Space Flight Center, Richard Smith from Kennedy Space Center, and Donald Hearth from the Langley Research Center.

Gentlemen, let me welcome you here today, and I want to extend my personal thanks to the center directors for their outstanding contributions to the shuttle program. The success we have realized with the shuttle could never have been achieved without your work and the excellent work done by your centers, and for that you should be recognized.

Before we proceed with Secretary Aldridge, I would like to have the opening statement of the gentleman from New Mexico, Congressman Lujan, entered into the record following my statement.

[The opening statement of Mr. Lujan follows:]

OPENING STATEMENT OF HON. MANUEL LUJAN, JR.

Thank you, Mr. Chairman, yesterday we heard some very interesting testimony from Mr. Beggs and Mr. Moore about the future direction of the Shuttle program. It is clear that there is a decision coming between whether the Shuttle program should remain with the government or be transferred to the private sector someday. In either case, it is important that the cost of the Space Transportation System be minimized. If the Shuttle is to be commercially operated, it will have to minimize cost in order to minimize the price and be competitive. If the Shuttle is to remain a government operated system, it will need to minimize in order that the total cost to the taxpayer is as low as possible.

Often we have heard about reducing the cost per flight by simply making more and more flights and dividing the fixed costs of the program by the number of flights. However, with the Space Station NASA will be coming to the Congress with increasingly larger budget requests, so we must be sure that the total cost of the Shuttle program is prudently examined, including how the total cost is affected by more or less flights with the Orbiter fleet of fixed size. Of special interest is the cost of maintenance, repair and logistic support, especially of the main engines.

As we move into the operational phase, it will be important to focus our attention on the reliabilitly of all subsystems and the costs of operation, including the maintenance and logistics support.

Yesterday we also heard about the various priorities in the shuttle program. In addition to minimizing cost, we have discussed the need for minimum schedule delays, for maximum safety, for maximum flexibililty, and for increased flight rate. These are all good priorities but they are not mutually consistant. For example, it may not be possible to have both maximum safety and minimum schedule delays. Likewise, the exphasis on flexibility will not help keep the costs down.

These are conflicting priorities. They would be easily resolved if we had a consensus in the future direction of the program. I hope that this series of hearings will be a big step in the direction of resolving this dilemma.

Thank you, Mr. Chairman.

Mr. VOLKMER. With that, Secretary Aldridge, you may proceed. Your statement will be made a part of the record in full. You may either summarize or review it in total, however you so desire.

STATEMENT OF HON. EDWARD C. ALDRIDGE, JR., UNDER SECRETARY OF THE AIR FORCE

Mr. Aldridge. Thank you, Mr. Chairman.

I am pleased to be here today to respond to the committee's request for reviews on the Air Force role in the space shuttle program. I am accompanied today by Dr. Charles Cook, Deputy Assistant Secretary of the Air Force for Space, Plans, and Policy; and Brig. Gen. Don Kutyna, Director of Space Systems Command Control and Communications.

I have a formal, prepared text which I will submit for the record. For the hearing this morning, I will provide the committee a brief oral summary of the prepared text and of course will be happy to answer any questions raised by the committee.

I will begin by commenting on the Air Force's dual role in the shuttle program as both a manager and as a user. On the management side, I will address the current plans to bring the Vandenberg shuttle launch facility to an operational status and our plans to improve the efficiency of that operation. Next, in response to the committee's request, I will assess the adequacies of the shuttle from DOD's viewpoint as a user.

Let me start off by giving you several pieces of good news. On the 14th of May, I had the priviledge of cutting the ribbon during the dedication ceremonies for the shuttle launch facilities at Vandenberg. At that time, I formally accepted these critical facilities from the builders, the Army Corps of Engineers, on behalf of the operators, the Air Force. The Vandenberg launch site is very nearly complete and is still on track to support an October 1985 first launch. I have provided the committee the latest photographs of the Vandenberg shuttle launch complex showing the status of construction, and I believe you have those photographs available to you.

The construction of the launch pad, launch control center, external tank processing facility, solid rocket booster processing facilities, and orbiter check-out and maintenance facilities is essentially complete. In May, we began ground systems tests to validate both the facilities and the equipment installed in the facilities. This test program is proceeding very well. Orbiter 101, the Enterprise, is still scheduled to arrive in November to begin tests to verify that the facilities and equipment will all interface correctly with flight hardware. In May of 1985, Orbiter 103, Discovery, will arrive to begin testing for our long awaited October 1985 launch.

Mr. Chairman, the schedule is very tight, as I told you when I testified to this committee in February, but we are still holding to that schedule and are confident that we can meet our launch date. Mr. Chairman, the Vandenberg launch facility is an indication of our commitment to make the shuttle a viable and valuable space launch system.

Another bit of good news has to do with our joint effort with NASA to improve the efficiency of the shuttle processing operations. The first major step in this effort was to revamp the team structure for STS operations to improve overall effiency. In October of last year, after a competitive source selection, the shuttle processing contract was awarded to a consortium of companies headed by Lockheed Space Operations Co. This team will be responsible for launching space shuttle missions at both Kennedy and Vandenberg Air Force Base.

Besides the potential for increased processing efficiency, we are of course pleased to note that all STS flights to date have been successful. At this time, all DOD performance requirements are being met for missions to be launched from the Kennedy Space Center. For future launches from Vandenberg, the majority of our requirements are being met. However, we have some concerns with lift capability which we are working closely with NASA to solve, upgrading the shuttle main engines to the 109 percent performance level, and use of the lightweight filament wound case solid rocket boosters will solve most of these performance shortfalls. Furthermore, we anticipate that all payload unique requirements are being met or will be met, including security and communications requirements.

Mr. Chairman, I would now like to address our efforts to provide the Department of Defense an assured and flexible space launch posture. As you know, the Secretary of Defense approved a new defense space launch strategy on February 7 of this year. Since my testimony before this committee last February, there have been a number of press reports and congressional inquiries which indicate that some misunderstanding persists on the Defense Departments' new space launch strategy. Let me again clarify some of these fundamental points.

First, under the new strategy, the new shuttle remains DOD's primary launch vehicle right into the next century. Contrary to some misinformed reporting, the Air Force is not abandoning the shuttle and is not dissatisfied with its performance to date.

Second, the modest number of expendable boosters, or ELV's, we are seeking as a complement to the shuttle are intended to be used to launch payloads. They are not intended to act solely as backup vehicles to shuttle flights as was done during the shuttle transition period. We do not advocate paying for two launch rides for any of our payloads.

Third, our new launch strategy was not developed under any illusion that it would be cheaper than the shuttle only system, but rather on what validated defense requirements dictate. However, we believe the cost to the Department of Defense of the new strategy will not be any more expensive than the shuttle only approach.

Finally, it is often mistakenly asserted that additional orbiters would solve the problem rather than a complimentary ELV system. While we must assure that there is a robust orbiter fleet, since the overwhelming majority of DOD launches will be on the shuttle, the addition of orbiters did not relieve the basic DOD concern. Any grounding of the shuttle or perceived vulnerability in crisis would affect all orbiters regardless of the number procured. We continue to view the modest ELV complement we are seeking as a prudent, affordable assurance against unpredictable but potentially crippling effects that could deny us access to space.

In evaluating DOD's space launch posture, we examined our requirements from the late 1980's to the next century. Our requirements broke down into two distinct groups: near-term requirements that can be satisfied by developments based on existing launch vehicles including shuttle derived vehicles; and far-term requirements for unmanned heavy lift vehicles of 100,000 to 250,000 pounds to orbit that require more extensive development.

The near-term launch requirements are well defined. They are based on existing, budgeted satellites that are in development or production. The launch vehicle must be capable of launching a shuttle class payload to a geosynchronous orbit. The vehicle must be compatible with the Centaur upper stage to ensure compatibility with the shuttle. We have selected two critical national security payloads for launch on this vehicle. We need to have the launch vehicle available in the late fiscal year 1988 or ealy fiscal year 1989 as the satellites become available for launch. Our request for proposal specified weight to orbit, payload size and upper stage compatibility, launch facility, and delivery date. We did not exclude any booster from consideration. In fact, we specifically designed the request for proposal to ensure that no contractor or candidate vehicle were excluded if they could meet our performance and schedule requirements.

To the extent that a shuttle derived ELV, based on proven flight hardware, meets our near-term requirements, including factors of cost, schedule, risk, and overall launch vehicle production base, it will be given a fair evaluation in the source selection with other ELV candidates.

Our far-term needs are different. Payloads in the mid-1990's and beyond that exceed the current shuttle capacity are not yet defined. We do have system concepts such as the strategic defense initiative, that may require launch vehicles capable of placing a 100,000 or 250,000 pounds of outsize payload in low Earth orbit. Development of launch vehicles for this size will require a great deal of development and engineering work. We have requested funding in the 1985 budget to begin requirements definition for this extremely large booster. We are also participating in a study with NASA to define a joint requirements for such a vehicle.

However, we do not believe our near term ELV Program, based on known requirements, should be deferred to begin a new and expensive space booster development, based on undefined requirements. The Secretary of Defense and all users of national security space payloads remain convinced that the complementary ELV system would serve several important functions for the Department of Defense and the Nation. First, it would be a modest hedge against unanticipated and unforeseen shuttle problems which might cause fleet groundings or outages. Second, it would provide a launch on demand flexibility for the Department of Defense for key national security payloads. Because of the Department of Defense flexibility, it also acts to reduce launch on demand pressures on NASA which have the undesired effect of bumping NASA's non-DOD customers to later flights.

Third, the ELV initiative would maintain an eroding U.S. launch system industrial base which will otherwise disappear. Finally, it maintains the United States as a viable international competitor in the ELV business which would otherwise go only to foreign firms.

These are all good reasons for us to pursue the maintenance of an ELV capability, but it is important to recognize that the fundamental compelling factor is the flexibility and confidence that ELV together with the shuttle provide the Nation for launch of national security payloads over the long term. We simply cannot afford to be in a situation, whatever the view of its likelihood, that could result in our being denied access to space.

Mr. Chairman, this concludes our remarks, and I will be glad and pleased to answer any questions that the committee has.

[The prepared statement of Mr. Aldridge follows:]

DEPARTMENT OF THE AIR FORCE

STATEMENT OF

HONORABLE EDWARD C. ALDRIDGE, JR.

UNDER SECRETARY OF THE AIR FORCE

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

HOUSE OF REPRESENTATIVES

CONCERNING

SPACE TRANSPORTATION SYSTEM - OPERATIONS AND MANAGEMENT

AUGUST 1, 1984

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

I WELCOME THIS OPPORTUNITY TO ADDRESS YOUR COMMITTEE TO PRESENT OUR VIEWS OF THE TWO AIR FORCE ROLES IN THE SPACE SHUTTLE PROGRAM: SPECIFICALLY, OUR ROLE AS A MANAGER AND OUR ROLE AS A USER. I AM ACCOMPANIED BY DR. CHARLES W. COOK, DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE FOR SPACE PLANS AND POLICY AND BRIGADIER GENERAL DON KUTYNA, DIRECTOR, SPACE SYSTEMS AND COMMAND, CONTROL AND COMMUNICATIONS. FIRST ON THE MANAGEMENT SIDE, I WILL ADDRESS THE CURRENT PLANS TO BRING THE VANDENBERG LAUNCH SITE TO AN OPERATIONAL STATUS AND OUR PLANS TO IMPROVE THE EFFICIENCY OF THAT OPERATION. NEXT, IN RESPONSE TO THE COMMITTEE'S REQUEST, I WILL ASSESS THE ADEQUACIES OF THE SHUTTLE FROM OUR VIEWPOINT AS A USER. AS A FOLLOW-ON TO THAT ASSESSMENT, I WILL ADDRESS THE AIR FORCE'S PLAN TO ACQUIRE AN EXPENDABLE LAUNCH VEHICLE TO SERVE AS A COMPLEMENT TO THE SHUTTLE, CONSISTENT WITH THE SECRETARY OF DEFENSE'S TASKING TO PROVIDE THE DEFENSE DEPARTMENT AN ASSURED ACCESS TO SPACE.

ON THE 14TH OF MAY, I HAD THE PRIVILEGE OF "CUTTING THE RIBBON" DURING DEDICATION CEREMONIES FOR THE SHUTTLE LAUNCH FACILITIES AT VANDENBERG. AT THAT TIME, I FORMALLY ACCEPTED THESE CRITICAL FACILITIES FROM THE BUILDER, THE ARMY CORPS OF ENGINEERS, ON BEHALF OF THE OPERATOR, THE AIR

FORCE. THE VANDENBERG LAUNCH SITE IS VERY NEARLY COMPLETE AND IS STILL ON TRACK TO SUPPORT AN OCTOBER 1985 FIRST LAUNCH. THE CONSTRUCTION OF THE LAUNCH PAD, LAUNCH CONTROL CENTER, EXTERNAL TANK PROCESSING FACILITY, SOLID ROCKET BOOSTER PROCESSING FACILITIES, AND ORBITER CHECK-OUT AND MAINTENANCE FACILITIES IS ESSENTIALLY COMPLETE. IN MAY, WE BEGAN GROUND SYSTEM TESTS TO VALIDATE BOTH THE FACILITIES AND THE EQUIPMENT INSTALLED IN THE FACILITIES. THIS TEST PROGRAM IS PROCEEDING VERY WELL. IN AUGUST, INERT SOLID ROCKET BOOSTER SEGMENTS WILL ARRIVE AT VANDENBERG, FOLLOWED BY THE NON-FLIGHT ORBITER, ENTERPRISE, IN NOVEMBER AND AN EXTERNAL TANK IN DECEMBER. THESE COMPONENTS WILL BE USED TO VERIFY THAT THE FACILITIES AND EQUIPMENT WILL ALL INTERFACE CORRECTLY WITH FLIGHT HARDWARE. IN MAY 1985, ORBITER 103, DISCOVERY, WILL ARRIVE TO BEGIN PROCESSING FOR OUR LONG AWAITED OCTOBER 1985 LAUNCH.

OUR SCHEDULE IS TIGHT, AS I TOLD YOU WHEN I TESTIFIED TO THIS COMMITTEE IN FEBRUARY, BUT WE ARE STILL HOLDING TO THAT SCHEDULE AND ARE CONFIDENT THAT WE CAN MEET OUR LAUNCH DATE. AS YOU KNOW, THE VANDENBERG LAUNCH FACILITY IS VITAL FOR THE ACCOMPLISHMENT OF THOSE POLAR ORBIT AND RETRIEVAL MISSIONS WHICH ARE NOT POSSIBLE OUT OF KENNEDY. BECAUSE OF THIS UNIQUE CAPABILITY, WE HAVE BEEN WORKING VERY HARD TO ENSURE VANDENBERG IS AVAILABLE ON TIME. WE ARE PROUD OF OUR

ACCOMPLISHMENTS IN THIS AREA, AND WE ARE EXCITED BY THE COMING DELIVERY OF THE ENTERPRISE TO PROVE OUT OUR EFFORTS.

WE HAVE WORKED CLOSELY WITH NASA TO IMPROVE THE EFFICIENCY OF SHUTTLE PROCESSING OPERATIONS. THE FIRST MAJOR STEP IN THIS EFFORT WAS TO REVAMP THE TEAM STRUCTURE FOR STS OPERATIONS TO IMPROVE OPERATIONS EFFICIENCY. IN OCTOBER OF LAST YEAR, AFTER A COMPETITIVE SOURCE SELECTION, THE SHUTTLE PROCESSING CONTRACT (SPC) WAS AWARDED TO A CONSORTIUM OF COMPANIES HEADED BY LOCKHEED SPACE OPERATIONS COMPANY. THIS TEAM WILL BE RESPONSIBLE FOR LAUNCHING SPACE SHUTTLE MISSIONS AT KENNEDY SPACE CENTER AND VANDENBERG AFB.

THE WINNING PROPOSAL REMOVED AN EXTRA LAYER OF MANAGEMENT OVERHEAD FROM THE ELEMENT CONTRACTORS (SOLID ROCKET BOOSTER, EXTERNAL TANK, AND ORBITER) AND PUT ALL ASSEMBLED COMPONENT PROCESSING UNDER A TEAM HEADED BY LOCKHEED. AFTER A SMOOTH TRANSITION PERIOD FROM THE PREVIOUS CONTRACTOR, THE SPC TOOK OVER ALL OPERATIONS IN THE SPRING OF THIS YEAR (STS-41C, APRIL 1984 LAUNCH). THEIR PERFORMANCE TO DATE HAS SHOWN CONSIDERABLE IMPROVEMENT IN STS PROCESSING EFFICIENCY. WE ANTICIPATE CONTINUED IMPROVEMENT AS THE STS SYSTEM MATURES AND THE VANDENBERG LAUNCH SITE COMES ON LINE.

ACTIONS ARE PLANNED THAT WILL ENSURE EVEN MORE EFFICIENT OPERATIONS AND USE OF RESOURCES. MEMBERS OF THE SPC TEAM WILL TRAVEL BETWEEN KENNEDY SPACE CENTER (KSC) AND

VANDENBERG TO ENSURE OPTIMUM USE OF MANPOWER AND TO KEEP TECHNICAL COMMUNICATION AT A HIGH LEVEL BETWEEN BOTH COASTS. CURRENTLY KSC RESIDENT PERSONNEL ARE AT VANDENBERG WORKING WITH THE AIR FORCE TEAM TO ENSURE A SUCCESSFUL ACTIVATION OF FACILITIES AND LAUNCH IN OCTOBER OF 1985. ALSO, FOR THE FIRST THREE LAUNCHES AT VANDENBERG, NASA WILL PROCESS AND CHECK-OUT THE ORBITERS AND THE EXTERNAL TANKS AT KENNEDY SPACE CENTER. THESE FUNCTIONS WILL THEN TRANSFER TO VANDENBERG FOR WEST COAST LAUNCHES. ADDITIONALLY, NASA WILL PROCESS THE AFT SKIRTS AND PARACHUTES FOR THE SOLID ROCKET BOOSTERS INDEFINITELY. THE AIR FORCE AND NASA TEAM EFFORT, AS WELL AS THE IMPROVED EFFICIENCY OF THE SPC, WILL ENSURE SUCCESSFUL SPACE SHUTTLE FLIGHTS AND A STEADILY IMPROVING OPERATIONAL EFFICIENCY.

TURNING NOW TO THE ABILITY OF THE SHUTTLE TO MEET OUR REQUIREMENTS AS A USER, I AM PLEASED TO NOTE THAT ALL PERFORMANCE REQUIREMENTS APPEAR ACHIEVABLE FOR MISSIONS TO BE LAUNCHED FROM THE KENNEDY SPACE CENTER. HOWEVER, WE HAVE SOME CONCERNS WITH LIFT CAPABILITY FROM VANDENBERG AIR FORCE BASE. WE ARE WORKING CLOSELY WITH NASA TO RESOLVE THESE CONCERNS AND IT APPEARS THAT UPGRADING THE SHUTTLE MAIN ENGINES TO 109% AND USE OF LIGHTWEIGHT FILAMENT WOUND CASE SOLID ROCKET BOOSTERS SHOULD GIVE US THE LIFT CAPABILITY WE REQUIRE IN THE NEAR TERM. FURTHER, ALL OTHER PAYLOAD UNIQUE

REQUIREMENTS SHOULD BE MET. THIS INCLUDES SECURITY AND COMMUNICATIONS REQUIREMENTS.

MR. CHAIRMAN, I WOULD NOW LIKE TO ADDRESS OUR EFFORTS TO ACQUIRE AN EXPENDABLE LAUNCH VEHICLE (ELV) TO COMPLEMENT THE SPACE SHUTTLE.

THROUGHOUT MILITARY HISTORY, IT HAS BEEN CLEARLY SHOWN THAT HAVING A MAJOR MILITARY CAPABILITY VULNERABLE AT A SINGLE NODE IS EXTREMELY DANGEROUS. IN FACT, OUR ENTIRE NUCLEAR DETERRENT POSTURE IS BASED ON THAT PREMISE -- THAT ANY ONE SYSTEM IS VULNERABLE. AS A RESULT, OUR DETERRENT IS BASED ON A TRIAD OF SYSTEMS: AIRCRAFT AND CRUISE MISSILES, LAND BASED ICBMs, AND SUBMARINE LAUNCHED BALLISTIC MISSILES. THE IDEA IS THAT THE VULNERABILITY OF ONE SYSTEM IS COMPENSATED FOR BY THE STRENGTHS OF ANOTHER SYSTEM.

OUR SPACE LAUNCH CAPABILITY DOES NOT HAVE THIS PROTECTION. WE ARE CURRENTLY USING A MIX OF EXPENDABLE LAUNCH VEHICLES AND THE SHUTTLE. HOWEVER, WE ARE TRANSITIONING ALL OF OUR PAYLOADS TO THE SHUTTLE AS THESE ELVs ARE USED UP. AFTER 1986 WE WILL NO LONGER HAVE ANY ELVs IN PRODUCTION. WE ARE ASSEMBLING THE LAST TITAN III FROM PARTS THAT WERE AVAILABLE AFTER THE TERMINATION OF THE TITAN PROGRAM LAST YEAR. WE ARE FLYING OUT OUR REMAINING ATLAS ICBMs MODIFIED AS ATLAS E SPACE LAUNCH VEHICLES. THE LAST PRODUCTION ELV, ATLAS H, WILL BE PRODUCED BY THE SPRING OF 1985. WHEN THESE

VEHICLES ARE LAUNCHED, BY 1989, WE WILL BE TOTALLY DEPENDENT ON THE SHUTTLE.

IN THE PAST, WHEN THE MAJORITY OF SPACE PAYLOADS WERE FOR RESEARCH OR SCIENTIFIC EXPLORATION, THIS DEPENDENCE ON SHUTTLE WOULD HAVE BEEN ACCEPTABLE. THE SITUATION HAS CHANGED, HOWEVER, AND THE NATION IS NOW MORE DEPENDENT ON SPACE SYSTEMS FOR ITS NATIONAL SECURITY. SPACE PAYLOADS PROVIDE EARLY WARNING, STRATEGIC AND TACTICAL COMMUNICATIONS, WEATHER, AND SURVEILLANCE INFORMATION THAT IS VITAL FOR THE FUNCTIONING OF THE NATIONAL COMMAND AUTHORITY AND OUR ABILITY TO DETER WAR. IT WOULD BE INCREDIBLY EXPENSIVE TO TRY TO REPLACE SPACE BASED SYSTEMS WITH OTHER SYSTEMS, AND IT IS CLEAR THAT WE COULD NEVER EQUAL THE CAPABILITY. IN THE FINAL ANALYSIS, WE CANNOT ACCEPT A SITUATION WHICH DENIES US THESE SPACE-BASED CAPABILITIES.

AS YOU KNOW, THE SECRETARY OF DEFENSE APPROVED A NEW DEFENSE SPACE LAUNCH STRATEGY ON FEBRUARY 7TH OF THIS YEAR. HE POINTED OUT THAT THE DEFENSE DEPARTMENT, UNLIKE COMMERCIAL AND SCIENTIFIC USERS OF SPACE, HAS UNIQUE REQUIREMENTS FOR AN ASSURED SPACE LAUNCH CAPABILITY UNDER VARYING CONDITIONS OF PEACETIME, CRISIS AND CONFLICT SITUATIONS. THE NEW STRATEGY WAS ISSUED IN RESPONSE TO CONCERNS EXPRESSED BY EVERY NATIONAL SECURITY USER OF SPACE, AND TOOK ACCOUNT OF SEVERAL INDEPENDENT STUDIES CONDUCTED ON THE SUBJECT. THE

UNANIMOUS CONCENSUS OF THESE USERS AND STUDIES HAS BEEN TO CONFIRM THE VIEW THAT DOD MUST NOT BE TOTALLY DEPENDENT ON THE SHUTTLE, AND SHOULD MAINTAIN AN EXPENDABLE LAUNCH VEHICLE CAPABILITY TO COMPLEMENT IT.

THE COMPLEMENTARY ELV SYSTEM WOULD SERVE SEVERAL IMPORTANT FUNCTIONS FOR THE DOD AND THE NATION:

- FIRST, IT WOULD BE A MODEST HEDGE AGAINST UNANTICIPATED AND UNFORESEEN SHUTTLE PROBLEMS WHICH MIGHT CAUSE FLEET GROUNDINGS OR OUTAGES.

- SECONDLY, IT WOULD PROVIDE LAUNCH-ON-DEMAND FLEXIBILITY TO DOD FOR KEY NATIONAL SECURITY PROGRAMS.

- BECAUSE OF THE INCREASED DOD FLEXIBILITY, IT ALSO ACTS TO REDUCE LAUNCH-ON-DEMAND PRESSURES ON NASA WHICH WOULD HAVE THE UNDESIRED SIDE EFFECT OF BUMPING NASA'S NON-DOD CUSTOMERS TO LATER FLIGHTS.

- THIRDLY, THE ELV INITIATIVE WOULD RETAIN A U.S. LAUNCH SYSTEM INDUSTRIAL BASE WHICH WILL OTHERWISE DISAPPEAR.

- AND FINALLY, IT MAINTAINS THE UNITED STATES AS A VIABLE INTERNATIONAL COMPETITIVE CAPABILITY IN THE ELV BUSINESS WHICH WOULD OTHERWISE GO TO FRANCE, OR EVEN THE SOVIET UNION.

THESE ARE ALL GOOD REASONS FOR US TO PURSUE MAINTENANCE OF AN ELV CAPABILITY, BUT IT'S IMPORTANT TO RECOGNIZE THAT

THE MOST COMPELLING FACTOR IS THE FLEXIBILITY AND CONFIDENCE THAT ELVs TOGETHER WITH THE SHUTTLE PROVIDE THE NATION FOR LAUNCH OF NATIONAL SECURITY PAYLOADS OVER THE LONG TERM. WE SIMPLY CANNOT AFFORD TO BE IN A SITUATION, WHATEVER THE VIEW ON ITS LIKELIHOOD, THAT DENIES US ALL ACCESS TO SPACE.

SINCE MY TESTIMONY BEFORE THIS COMMITTEE IN FEBRUARY THIS YEAR, THERE HAVE BEEN A NUMBER OF PRESS REPORTS AND CONGRESSIONAL INQUIRIES WHICH INDICATE THAT SOME MISUNDERSTANDING PERSISTS ON THE DEFENSE DEPARTMENT'S NEW SPACE LAUNCH STRATEGY. LET ME AGAIN CLARIFY SOME OF THE FUNDAMENTAL POINTS:

- FIRST, UNDER THE NEW STRATEGY, THE SHUTTLE REMAINS DOD'S PRIMARY SPACE LAUNCH VEHICLE RIGHT INTO THE NEXT CENTURY. CONTRARY TO SOME REPORTING, THE DOD IS NOT ABANDONING THE SHUTTLE AND IS NOT DISSATISFIED WITH ITS PERFORMANCE TO DATE.

- SECONDLY, THE MODEST NUMBER OF ELVs WE ARE SEEKING COMPLEMENT THE SHUTTLE AND WILL BE USED TO LAUNCH PAYLOADS. THEY ARE NOT BACK-UP VEHICLES TO SHUTTLE FLIGHTS. WE DO NOT INTEND TO PAY FOR TWO LAUNCH RIDES FOR ANY OF OUR PAYLOADS.

- THIRDLY, OUR NEW LAUNCH STRATEGY WAS NOT DEVELOPED UNDER ANY ILLUSION THAT IT WOULD BE CHEAPER THAN A SHUTTLE-ONLY SYSTEM, BUT RATHER ON WHAT THE VALIDATED DEFENSE REQUIREMENTS DICTATE. AS IT HAPPENS, WE BELIEVE THE COSTS TO

THE DOD OF THE NEW STRATEGY WILL BE ABOUT THE SAME OR SOMEWHAT LESS THAN THE SHUTTLE-ONLY APPROACH.

- AND FINALLY, IT IS OFTEN MISTAKENLY ASSERTED THAT ADDITIONAL ORBITERS, RATHER THAN A COMPLEMENTARY ELV SYSTEM, WOULD SOLVE THE PROBLEM. WHILE WE MUST ASSURE THERE IS A ROBUST ORBITER FLEET, THE ADDITION OF ORBITERS DOES NOT RELIEVE THE BASIC DOD CONCERN. ANY GROUNDING OF THE SHUTTLE OR PERCEIVED VULNERABILITY IN A CRISIS WOULD AFFECT ALL ORBITERS REGARDLESS OF THE NUMBER PROCURED. WE CONTINUE TO CONSIDER THE MODEST ELV COMPLEMENT AS PRUDENT, AFFORDABLE INSURANCE AGAINST UNPREDICTABLE, BUT POTENTIALLY CRIPPLING EVENTS WHICH COULD DENY US ALL ACCESS TO SPACE.

WE FEEL THAT HAVING OUR TOTAL LAUNCH CAPABILITY PLACED ON THE SHUTTLE IS AN UNACCEPTABLE RISK. WE BELIEVE THAT THIS RISK CAN BE REDUCED BY DESIGNING CERTAIN SELECTED CRITICAL PAYLOADS AS DUAL COMPATIBLE, THAT IS, CAPABLE OF LAUNCH ON EITHER THE SHUTTLE OR AN ELV.

OUR ELV PLANS CALL FOR THE DEVELOPMENT AND PRODUCTION OF 10 LAUNCH VEHICLES FOR USE BETWEEN FY 89 AND FY 93. WE PLAN TO FLY TWO SATELLITES PER YEAR ON THIS ELV. THE ELV WILL BE DESIGNED TO ACCOMMODATE SHUTTLE CLASS SATELLITES. THUS, IT WILL BE CAPABLE OF PLACING 10,000 POUNDS INTO A GEOSYNCHRONOUS ORBIT. IT WILL BE CAPABLE OF LAUNCHING SATELLITES THAT ARE 15 FEET IN DIAMETER BY 40 FEET LONG, AND IT WILL USE A CENTAUR CLASS UPPER STAGE TO ENSURE COMPATIBILITY WITH SHUTTLE. IF THE SHUTTLE IS GROUNDED, WE CAN USE THE ELV. IF THE ELV IS UNAVAILABLE, WE WILL BE ABLE TO USE THE SHUTTLE. IN EITHER CASE, WE WILL HAVE ACCESS TO SPACE FOR THESE CRITICAL PAYLOADS.

IN EVALUATING OUR LAUNCH VEHICLE NEEDS, TO DEFINE THE LIFT REQUIREMENTS FOR THE ELV, WE EXAMINED OUR REQUIREMENTS FROM THE LATE 1980s INTO THE NEXT CENTURY. OUR REQUIREMENTS BROKE DOWN INTO TWO DISTINCT GROUPS -- NEAR-TERM REQUIREMENTS THAT CAN BE SATISFIED BY DEVELOPMENTS BASED ON EXISTING LAUNCH VEHICLES, INCLUDING SHUTTLE DERIVED VEHICLES, AND FAR-TERM REQUIREMENTS FOR UNMANNED HEAVY LIFT VEHICLES (100,000 TO 250,000 POUNDS TO ORBIT) THAT REQUIRE MORE EXTENSIVE DEVELOPMENT.

THE NEAR-TERM LAUNCH REQUIREMENTS ARE WELL DEFINED. THEY ARE BASED ON EXISTING, BUDGETED SATELLITES THAT ARE IN DEVELOPMENT OR PRODUCTION. THE LAUNCH VEHICLE MUST BE CAPABLE OF LAUNCHING A SHUTTLE CLASS PAYLOAD TO A GEOSYNCHRONOUS ORBIT. THE VEHICLE MUST BE COMPATIBLE WITH THE CENTAUR UPPER STAGE TO ENSURE COMPATIBILITY WITH THE SHUTTLE. WE HAVE SELECTED TWO CRITICAL NATIONAL SECURITY PAYLOADS FOR LAUNCH ON THIS VEHICLE. WE NEED TO HAVE THE LAUNCH VEHICLE AVAILABLE IN LATE FY 88 OR EARLY FY 89 AS THE SATELLITES BECOME AVAILABLE FOR LAUNCH. OUR REQUEST FOR PROPOSAL

SPECIFIED WEIGHT TO ORBIT, PAYLOAD SIZE AND UPPER STAGE COMPATIBILITY, LAUNCH FACILITY, AND DELIVERY DATE. WE DID NOT EXCLUDE ANY BOOSTER FROM CONSIDERATION; IN FACT, WE SPECIFICALLY DESIGNED THE REQUEST FOR PROPOSAL TO INSURE THAT NO CONTRACTOR OR CANDIDATE VEHICLE WAS EXCLUDED IF IT COULD MEET OUR PERFORMANCE AND SCHEDULE REQUIREMENTS.

OUR FAR-TERM NEEDS ARE DIFFERENT. PAYLOADS IN THE MID-1990s AND BEYOND THAT EXCEED 10,000 POUNDS ARE NOT YET DEFINED. WE DO HAVE SYSTEM CONCEPTS, SUCH AS THE STRATEGIC DEFENSE INITIATIVE, THAT MAY REQUIRE LAUNCH VEHICLES CAPABLE OF PLACING 100,000 - 250,000 POUNDS OF OUTSIZE PAYLOAD IN LOW EARTH ORBIT. DEVELOPMENT OF LAUNCH VEHICLES OF THIS SIZE WILL REQUIRE A GREAT DEAL OF DEVELOPMENT AND ENGINEERING WORK. WE HAVE REQUESTED FUNDING IN THE FY 85 BUDGET TO BEGIN REQUIREMENTS DEFINITION FOR THIS EXTREMELY LARGE BOOSTER. WE ARE PARTICIPATING IN AN AERONAUTICS AND ASTRONAUTICS COORDINATING BOARD STUDY WITH NASA TO DEFINE JOINT REQUIREMENTS FOR SUCH A VEHICLE.

HOWEVER, WE DO NOT BELIEVE OUR NEAR-TERM ELV PROGRAM, BASED ON KNOWN REQUIREMENTS, SHOULD BE DEFERRED TO BEGIN A NEW AND EXPENSIVE SPACE BOOSTER DEVELOPMENT, BASED ON UNDEFINED REQUIREMENTS. TO THE EXTENT THAT A SHUTTLE DERIVED ELV, BASED ON PROVEN FLIGHT HARDWARE, MEETS OUR NEAR-TERM REQUIREMENTS, INCLUDING FACTORS OF COST, SCHEDULE, RISK, AND OVERALL LAUNCH VEHICLE PRODUCTION BASE, IT WILL BE GIVEN A FAIR EVALUATION IN THE SOURCE SELECTION WITH OTHER ELV CANDIDATES.

THIS CONCLUDES MY FORMAL STATEMENT, MR. CHAIRMAN. I WILL BE PLEASED TO ADDRESS ANY QUESTIONS THE COMMITTEE MIGHT HAVE.

Mr. **Volkmer**. I will now recognize the gentleman from California, Mr. Brown.

Mr. **Brown**. Thank you, Mr. Chairman.

Mr. Aldridge, would you clarify for me something about the number and type of ELV's that are being contemplated here? Are you defining a strategy that contemplates a large number of different sizes and weights of payloads that you can have a mix of different kinds of ELV's?

Mr. **Aldridge**. Sir, our launch strategy is based on, hopefully, a complement of different sizes, depending on the payload. The proposal that I have spoken of deals only with a class of ELV that is capable of launching a payload comparable to that which can be launched on the shuttle. Our plan for that is to go into competition, and there are several possible boosters that could come from that competition, such as a derivative of the existing Titan 34-D, a derivative of the existing Atlas booster, or a shuttle derived launch vehicle. We have not selected which one of those will meet our overall requirements, but once we have selected a winner for that particular class of vehicle, our plan is to procure 10 of those vehicles, and plan to launch approximately two per year for a period of 5 years, from 1988 or 1989 to 1992.

After 1992, we anticipate that some heavy lift vehicle would be anticipated which would meet our requirements for both the strategic defense requirement and perhaps for the space station.

Mr. **Brown**. Could you tell us what the heaviest defense required launch is, what it is for, or is that something you don't care to discuss?

Mr. **Aldridge**. Of the current satellites, yes, sir. Our requirements are to place a satellite of approximately 10,000 pounds into geosynchronous orbit from the eastern test range. We do not plan to fly, at this point, any of the ELV's from Vandenberg Air Force Base. They would all be launched from Kennedy Space Center.

Mr. **Brown**. That is 10,000 into geosynchronous.

Mr. **Aldridge**. Yes, sir.

Mr. **Brown**. That would be like a weather satellite or something.

Mr. **Aldridge**. Communications satellites, sir.

Mr. **Brown**. What about a heavier low Earth orbit of 30,000 pounds?

Mr. **Aldridge**. The shuttle is designed for the future to carry 32,000 pounds in low Earth orbit. Those are typically polar orbits out of Vandenberg. It is not our intent to fly these ELV's out of Vandenberg.

Mr. **Brown**. No ELV's out of Vandenberg.

Mr. **Aldridge**. No, sir.

Mr. **Brown**. I have been concerned about the next generation needs, and I don't know whether it is appropriate to bring it up here or not, but looking at these charts that project through the end of the century, I am really—I think we need to introduce the idea that we are going to need a transportation system from the Earth station to geostationary orbit and beyond, that is, an orbital transfer vehicle to link with that. I don't see them anywhere in these charts. I would like to inquire if the Air Force has done any thinking or planning that could be available to us with regard to that next phase of transportation in space?

Mr. ALDRIDGE. Yes, sir. We have studies internal to the Air Force, and we have a joint board that exists between the Department of Defense and NASA looking into the heavy lift vehicle requirements for the future. Unfortunately, we have no definitive requirements for what that vehicle should look like.

And that is fairly logical. We don't build payloads that are incapable of being launched from existing boosters, so since we don't have a booster of that class, we obviously don't have payloads that are designed for that class of booster at this time.

We are studying what future requirements might look like. It is clear in my mind that the strategic defense initiative and perhaps the space station will need orbital launch capabilities of that class, but precisely the size and the weight that is needed to be delivered is still somewhat uncertain. We have these studies underway to try to define that a little more precisely, but right now there are no definitive requirements.

It is clear, and I doubt there is any controversy at all that exists between ourselves and NASA or any other user, that we will need in the mid-1990's a heavy lift vehicle class and we are proposing in our 1985 budget to get on with the requirements for such a vehicle so that we can define it and get that development underway.

Mr. BROWN. So, you do have a proposal to define a vehicle in the 1985 budget which could lead to the research and development in 1986 and——

Mr. ALDRIDGE. It would begin—our 1985 budget request included $2 million for a study effort for a heavy lift vehicle for the mid-1990's. I understand that Congress has also added to the NASA budget approximately $6 million for the same thing. We would propose, as is being worked now as a task of the AACB, a DOD-NASA joint agency for the study, to define what those requirements are, a joint study. I think it is clear it must be joint, what the requirements look like in the mid-1990's, it does not satisfy our near-term needs based upon known requirements, but it would start in the 1985 budget. It would begin probably to increase somewhat in the 1986 budget, but the large development dollars would not occur until probably the end of the 1980's.

Mr. BROWN. One of the things that fascinates me, I am looking at the SDI, which I do quite often, is the amount of payload that would have to be lifted into orbit, including hardware and fuel for energy supply, and I just wondered if somebody up there is thinking about how to provide the capacity to do all that.

Mr. ALDRIDGE. Yes, sir. They certainly are. But as I mentioned before, exactly how much, what size, the volume constraints, and things like that are still undefined because we haven't got a concept yet in SDI. We have some ideas, we have some technology programs, but as far as what is the concept for deployment, it is yet undefined.

Mr. BROWN. Thank you, Mr. Chairman.

Mr. VOLKMER. The gentleman from Florida.

Mr. MACKAY. Yesterday, we had testimony from Mr. Beggs in which he indicated that the RFP by the Air Force for their new ELV actually didn't give NASA with its shuttle-derived technology a fair shake because it was designed in a way to favor a modified Titan or an upgraded Atlas. It would appear to me that we are going to have a need, other than DOD's need, for heavy lift capability, and that it might be in the interest of the country to allow NASA to continue working with the shuttle-derived technology by adding more engines, clustered. It would appear to me that DOD is, in effect, locking us into a situation where there is going to be duplicate expenditures. I would appreciate your comments on that and also your comment on whether the specification of Titan launch facilities doesn't in effect say we want a new Titan.

Mr. ALDRIDGE. Yes, sir. I checked on that this morning, because I was accused that we had put such a restriction in the proposal. I checked with California at 6 o'clock this morning their time, and they assured me that no such provision is in the RFP. We are not trying to restrict any bidder who wants to bid the proposal to such a constrained case. What we have specified in the RFP was a weight to orbit and a date of need, and any bidder who wants to bid under those conditions under a financing scheme that has been modified from the previous proposal where we incrementally or fully fund the development cost can bid such a proposal.

I am sorry that there has been any misunderstanding of that, but it is not our intent to foreclose anyone who wants to bid any booster that meets our requirements. We will evaluate them on a fair basis based upon cost and schedule and risk and all the other factors that go into meeting our launch need. It is not my intent to foreclose anybody who wants to bid under those conditions.

Mr. MACKAY. Suppose NASA bid a ELV based on existing shuttle technology and said we propose to pay part of the cost ourselves and the Air Force pay that part of the development costs which relate solely to the mission. Would that meet your RFP requirements?

Mr. ALDRIDGE. Sir, I——

Mr. MACKAY. I am worried about it from the country's standpoint and not the individual institution or empire.

Mr. ALDRIDGE. Yes, sir, and that is my objective as well, is to look at it from the country's point of view.

Mr. MACKAY. It looks like each empire will have its own, but we will end up paying for two, and that is the thing that bothers me. It really doesn't matter to me how we get it up there. We are going to have to have heavy military payloads in space if we have a manned space station. We are probably going to have to have heavy civilian payloads in space, and then we are going to have to question NASA about why they can't use the one that you have developed.

Mr. ALDRIDGE. Mr. MacKay, I have not seen the NASA proposal, but it is my understanding from the technical experts who understand it that studies have been done looking at a shuttle-derived launch vehicle based on flight proven technology, that a shuttle-derived launch vehicle to meet our near-term requirements is not growable to meet the long-term requirements. So, we would have to in fact develop two different concepts. One of the concepts would be to meet the 10,000 pounds the geosynchronous orbit using a booster specifically designed for that purpose and then to start all over again for a heavy lift vehicle of a shuttle-derived or those components for the future. We think that that is a waste of money, and the best solution is to use the existing type of hardware that can exist today to meet our requirements today and to get on with minimum research and development costs and get on with a longer term program for heavy lift vehicle that will, in fact, be expensive and take time to develop.

But those technical judgments are yet to be evaluated because the proposals are not due back on our RFP until the 20th of August, but we are not foreclosing any commercial firm bidding. One point is that I am prohibited by Federal regulations to accept a bid from a Government agency that competes with a commercial firm. However, I am trying to avoid that particular conflict by trying to be as fair in this evaluation as possible. We would hope that a commercial firm would in fact bid for a shuttle-derived launch vehicle based upon our requirements, and they have refused to do so.

Mr. MacKay. Actually, the RFP will result in a launch vehicle that for the first time will be able to duplicate and compete with the shuttle's capabilities, so that actually looked at in a different way, you are going to put into business somebody to compete with NASA.

Mr. Aldridge. Sir, I am looking at it from the point of view of what is the primary thing as far as national security and the view of the Nation, and that is to make sure we can have our payloads placed in orbit when we need them and that will meet our requirements. I believe that the ELV, combined with the massive number of shuttle launches still planned by DOD, provides the Nation with a more robust and flexible launch vehicles than would be available with shuttle only. That is the objective I am trying to pursue.

Mr. MacKay. One of your final comments was that this proposal would keep the United States as a viable competitor with European ELV's. I don't see that as an appropriate policy consideration for the Department of Defense.

Mr. Aldridge. It is one of the factors that should go in my advice to this committee that should be considered in one of the factors in judging whether or not DOD has a viable plan. It is, I believe, important that some commercial firms would like to use fly United States and I think it is important for them to do so and to have two of the three possible launch vehicles is better than having only one. Yet, I believe that in some cases that I would see that the new ELV is not a competitor necessarily for the shuttle, but a competitor for Ariane, and I think that is important for the United States to consider.

Mr. MacKay. Thank you, Mr. Chairman. Thank you, Mr. Aldridge.

Mr. Volkmer. I would like to ask several questions. You mentioned that the RFP didn't necessarily preclude and provide for any specific launch facility, yet in your statement I would like to know what you mean by, on page 11, in the criteria, "our request for proposal specified weight to orbit, payload size and upper stage compatibility," and then "launch facility"——

Mr. Aldridge. Yes, sir. That meant Kennedy launch facility. We only plan to fly the ELV's out of the Kennedy launch complex because the plan right now is to only place those payloads going to geosynchronous orbit. They would be launched only from the Kennedy launch center.

Mr. **Volkmer**. Now, It appears to some of us, and even though you keep assuring us that the shuttle and you're satisfied with its performance and that's not the nonperformance of the shuttle is not the reason for the complementary ELV—that it is for basically to make sure for national security payloads that you have, I don't want to say backup, that you have an availability, let's put it that way. My question is, what are we presently using, what have you used for the last 5 years?

Mr. **Aldridge**. We have used a combination of vehicles, Atlas. We have used Titan, Titan III, Titan 34, Tital 3-B with Agina upper stages, Titan with Transstage, Titan with IUS. We have even launched some Delta in the past.

Mr. **Volkmer**. But basically aren't your heavier payloads presently and in the past year or so been used for the Titan?

Mr **Aldridge**. Yes, sir. Well, there are variations of Titan.

Mr. **Volkmer**. I realize that.

Mr. **Aldridge**. There are a series of those, and we have used those with Atlas as well.

Mr. **Volkmer**. The Titan has been basically the first stage missile. Is that correct?

Mr. **Aldridge**. There are so many variations. In some cases, the first stage and core vehicle. Then, in other cases, like 34-D, we use the Titan with two solid rocket boosters on the side as the first stage.

Mr. **Volkmer**. My basic question is to that Titan, what have you been using as a backup or as a complementary.

Mr. **Aldridge**. Sir, we haven't, other than the fact that—the point you are trying to get at is that we have a variety of launch vehicles to launch a variety of payloads to orbit. We are not depending on just the Titan for launching all of the national security payloads. We use a variety of launch vehicles based upon variations of Titan and Atlas and even smaller payloads. We have not, in the past, been dependent on one vehicle for launch of all payloads.

Mr. **Volkmer**. Now, with the ELV, it appears to me at least, one of the arguments that you are putting forth is that you will be able to have a launch on demand.

Mr. **Aldridge**. Yes, sir.

Mr. **Volkmer**. Is that correct?

Mr. **Aldridge**. Yes, sir.

Mr. **Volkmer**. Have there been any delays in the past in launch of your satellites?

Mr. **Aldridge**. From the shuttle, sir?

Mr. **Volkmer**. No, from the ELV's.

Mr. **Aldridge**. Yes, sir. There have been many delays for a wide variety of reasons.

Mr. **Volkmer**. What is launch on demand, then?

Mr. **Aldridge**. Let me give you an example where the problem can be illustrated with the shuttle. Last year, we had a payload which sat on the pad for a variety of reasons, both because of existing satellites in orbit, because we had a problem with the satellite itself, some of these things don't work all the time, and we had a problem with the booster. It sat on the pad for 7 months for those reasons, all of which contributed to the delay.

We could not afford to have that payload integrated on the shuttle and have it sit on the pad for 7 months, because that shuttle has to go place other people into orbit. So, we would have gone through the dilemma of leaving it on the pad for 7 months or letting that go and work on its other mission performers. Then, when the payload was ready to fly, we would have had to call it up, and we would have had to bump some commercial user who had been planning to fly on a particular date, and we would have had to exercise our bumping privileges and bring that shuttle back to the launch pad to relaunch with all the difficulties that has of now reintegrating the payload onto the orbiter, taking the payloads out of the shuttle bay for the commercial users. Then, of course, once we fly, they have to go back and make that case.

In that particular payload, which is a classified payload, we could not afford to have those kind of delays occur. So, our proposal is to take those types of payloads that are critical to be launched when they are available to be launched and put those on the ELV so that we avoid having to place NASA in the dilemma of its non-DOD customers of bumping them off.

Mr. **Volkmer**. In other words, what you are telling me is, as I understand it, launch on demand doesn't necessarily mean within a timeframe that is absolutely necessary but that the satellite itself, whatever type it is, is the criterion as the determining factor.

Mr. **Aldridge**. The criteria is the satellite, is whatever we are trying to place into orbit, the issue in which the launch system is not the important factor. Getting that payload into orbit is the important factor.

Mr. **Volkmer**. But it is not necessarily important that it be there at a certain time.

Mr. **Aldridge**. Yes, sir. In this particular case, it was extremely important that it get there at a particular time.

Mr. **Volkmer**. But if you had delays, as you had with your Titan in the past, whatever ELV you do produce, if you have delays it is not necessarily going to get there on time, either.

Mr. **Aldridge**. But that ELV is assigned to that particular payload, and when that payload is ready to go, that ELV is usually ready to go. I don't have to worry about bumping or recalling shuttles under those kind of conditions.

The point, Mr. Chairman, is that not all of our payloads require that type of demand. It is only a very few. What we have tried to do is take those very few, the one or two, and to place those on the ELV's so that we avoid this problem of bumping and putting pressure on NASA to throw off paying customers from the shuttle to meet our needs.

Mr. **Volkmer**. The next thing that concerns me is that you have already, the Defense Department, expressed interest in the use of the shuttle as so many in the outyears, whether we go through 1985, 1986, 1987, 1989, 1990, 1991, 1992, right on. Basically, and I know that that can vary, however, when we look at the whole picture, we go back to 1982, I believe in July, and we find that at that time there was a letter from, if I remember right, OMB, that says that the shuttle is basically—its principal purpose for the use of the Department of Defense, which led us to believe that DOD is to be able to bump everybody, and you have used that expression.

Mr. **Aldridge**. Yes, sir.

Mr. **Volkmer**. Now we get to the position where some of us are looking at it and saying, well, you have the right to bump everybody but you are also expressing the right not to use it at certain times.

Mr. **Aldridge**. Yes.

Mr. **Volkmer**. Which, if you look at it, creates a little bit of a dilemma, does it not?

Mr. **Aldridge**. I am not sure I follow the point.

Mr. **Volkmer**. All right. Let me put it this way. Let's assume that in 1983, DOD projections were that you would utilize the shuttle for, say, 8 flights out of a projected 24. Those are basically partially or fully dedicated. But, under the present criteria as I understand it, up to 1 year before, you can hold that eight and then 1 year before you can say, no, we only want two, or we only want six, or we only want seven.

Mr. **Aldridge**. Yes, sir. We have a memorandum of agreement with NASA that has a 3-year running plan, and the plan would be that we would project out 3 years to our need. We would pay for the first 2 years, which is essentially because I can't commit the Congress to spending money until they address the President's budget. The plan is, once the President's budget comes to Congress, we are obligated to NASA to pay for the number of launches 2 years in advance, and we provide those funds which are included in the President's budget to do so.

Then, we give NASA a plan for the third year, which we are not committed to because we can't commit the Congress to fund in the third year because you have not received that budget. So, there is essentially a 3-year plan, a 2-year commitment, and if we don't fly that second year, if we drop off, we are still committed to NASA to pay for that flight.

Mr. **Volkmer**. That is not quite the same testimony, if I remember right, that Administrator of NASA, Mr. Beggs, gave yesterday.

Mr. **Aldridge**. Sir, I can provide you a detailed report on that for that particular MOA, and that it what it says.

Any time we slip a flight, if we move from a fiscal year, once the budget is submitted, then we are committed to NASA to pay for that flight, but if we don't fly and move it to the next year, we get credit for that particular flight because we have paid them the money for that, and if there is a change in the pricing policy, we are committed to pay for that additional increase in price.

Mr. **Volkmer**. But that just puts it off and NASA has to owe you, basically, a flight in the following year.

Mr. **Aldridge**. We have paid them for that flight and they owe us one in the future. That is correct.

Mr. Chairman, don't penalize us for success. Normally, the reason for those flight delays are a result of we have to commit several years in the future to launch a satellite on a particular day based upon an anticipated failure rate. We have to manifest a shuttle flight for that particular anticipated failure. We have been very fortunate, in the past, that we have been successful. Normally those satellites are lasting much longer once we get them on orbit than we anticipate. We still have to plan for the failure date, but because they are lasting longer, we don't have to launch those other expensive satellites to replace it, under normal conditions, and therefore you do see a decrease in the commitment with orbiter as a function of time. It is because of success, not as a result of failure.

Mr. VOLKMER. Perhaps you don't see it as I do, the dilemma that can face those persons who are firmly convinced that first, we should fly the shuttle as many times as we can and as efficiently as possible. What I see as an outgrowth of this is a good projection of possible inefficiencies for Government operations.

Mr. ALDRIDGE. Mr. Chairman, you and I are not in disagreement at all on that function, except I have a viewpoint that my primary function is to get our payload into orbit in the most effective and efficient way possible, because that is the mission, payload in orbit, not necessarily the vehicle that got it there, and I need to have a vehicle, stable of launch vehicles, a variety of types, that we can use in the most efficient way possible to make sure we get those payloads in orbit on time and in the best way possible and the most reliable way possible. That is the fundamental objective, and my concern is not necessarily whether the orbiter is the right answer or whether an ELV is the right answer, but a very competent and confident launch vehicle system is what we really need for the country. That is what I am trying to pursue.

Mr. VOLKMER. All right. Does the RFP basically lead to a Titan, Atlas, whatever type, with a Centaur upper stage?

Mr. ALDRIDGE. Yes, sir.

Mr. VOLKMER. That Centaur upper stage will be the same one basically that would be shuttle compatible?

Mr. ALDRIDGE. Yes, sir. We have established that as one of the criteria because we are integrating our payloads in the shuttle with a Centaur and that Centaur would be compatible with the ELV.

Mr. VOLKMER. What if we have difficulties with the Centaur? What is your backup or complementary to the Centaur?

Mr. ALDRIDGE. We have a possibility of using an inertial upper stage, but basically the weights that we are seeing in our payloads say that the Centaur is really the only vehicle we have for flights off the ELV or the shuttle for geosynchronous orbits. However, one must recognize that the reliability that we have now seen in the Centaur over something like 140 launches is basically the same vehicle with some minor structural modifications. It is different than starting all over, again with a new development. It is basically based upon proven reliable technology.

Mr. VOLKMER. But you are not saying that the shuttle is not reliable.

Mr. ALDRIDGE. No, sir, we are not saying that. In fact, we hope that it becomes very reliable because most of our flights must be on the shuttle. It must be reliable.

Mr. VOLKMER. You mentioned the IUS. Where are we on the IUS?

Mr. ALDRIDGE. Yes, sir. We are in the process of delivering the solid rocket boosters to Kennedy for launch toward the end of this year, and we are anticipating that that will go successfully. Everything looks good now on the IUS. We think we have found the problems and we are getting ready to launch.

Mr. **Volkmer**. You anticipate a launch in early 1985?

Mr. **Aldridge**. No, sir.

Mr. **Volkmer**. Using the IUS?

Mr. **Aldridge**. Late 1984.

Mr. **Volkmer**. Late 1984.

I now recognize the gentleman from Florida.

Mr. **Nelson**. Thank you, Mr. Chairman, good morning, Mr. Secretary.

I think the concerns that you have heard expressed from this committee are due to the fact that we have been operating over a period of years with the conditions set forth by the President in 1972 that we were going to develop the space transportation system. Until recently, indeed, until your appearance before this subcommittee in February, the opinion still on the street was that there would be the phase out of the ELV's over a period of time as the shuttle became operational. It was your appearance in front of this committee that ultimately started to circulate in the press in which you stated no, that you wanted an additional 10 ELV's, 2 per year over 5 years starting in 1988.

Now, why did you select that particular time as opposed to an earlier time, to concur and confer with the Congress and the policymakers?

Mr. **Aldridge**. Yes, sir, I would be glad to answer that.

When we started—let me start in the beginning of I guess really back in 1978 where the commitment to the shuttle-only policy was instituted. There was, quite honestly, a lot of footdragging within the Department of Defense on that particular issue of whether or not that was a good policy. We made our case. The President said, no, we are going to proceed down a path of shuttle only. At that time, the conditions under which we were anticipating the operation of the shuttle said that that was probably an acceptable decision. The reason was we were going to have five orbiters, all full performance capable, all meeting all of DOD's requirements, with turnaround times of 160 hours, I believe was the number, with a launch cost of one-third the cost of an ELV, and with we thought a fairly robust program for logistics and support so that we could maintain the 160 hours of turnaround.

It has not been until the last really 2 years since we have launched the shuttle, seen it turn around, began to do the real live problems of trying to integrate our payloads into the orbiter bay, seen the difficulties of the interface requirements of that particular system, all those things which we are now learning about the orbiter and which we did not anticipate with the degree of difficulty that existed when we signed up.

It doesn't mean that these are insurmountable problems. Basically, we have to rely on the orbiter because we are still going to fly it many, many times. But those conditions didn't exist and we really didn't know what the real cost was going to be to the Department of Defense or even to the Nation until about 2 years ago, and the difficulties of seeing the orbiter in operation said well, was that really a right decision in 1978? It took us some time to filter all of those things and to look at the cost and look at the reliability and our dependence upon the orbiter and the real live operational considerations of the orbiter fleet that said well, maybe not.

It took some time to discuss that issue within the Department of Defense. We raised it at all the users of the satellites and the shuttle, the Air Force being the prime user, but the decisionmakers themselves in the administration, including the Director of Central Intelligence, the President's National Security Adviser, the Secretary of Defense. All of these people were consulted about well, was this the right answer. And it really wasn't until all the factors of the real life orbiter parameters started to come in 2 years ago that these factors could be considered in the real terms.

At the end of those discussions, last year, the decision was made, let's build ourselves a complementary launch system so that we have a launch complex, a launch system that consists of as robust a network of launch vehicles as we can get. When we made that decision, I think, two things happened. One is that it was made based upon logical and reasoned judgments of the policymakers that need to make those decisions, but it wasn't until recently that we had the opportunity to come forth to this committee and say we think we ought to change.

On top of that, it requires a decision now. If we could have delayed it for another year or two, we probably would have. But unfortunately, the space launch production capacity of this country is drying up. We do not have a fifth orbiter plan. We are trying to get one. I know you are working on that, but there is not one in the budget right now that we are going to pursue. The Titan line will dry up this year, and the Atlas line will dry up next year. There is no continuing production base for space launch vehicles in this country. So, the decision time is now if we are going to provide for such a capability. That is why we came before this committee, because its time was now, it was based upon reasoned judgment, and we think that that reasoned judgment is correct.

Mr. NELSON. You said the decision was made last year. When was that made?

Mr. ALDRIDGE. Sir, I can't point to any particular time, but the one event that I think gave us the direction was September 7* when the Secretary of Defense signed the space launch strategy. There was probably some time before that it was actually made, but that was the implementer that I am now operating under.

Mr. NELSON. Why would you want to wait some 5 or 6 months before you shared that conclusion with the Congress?

Mr. ALDRIDGE. The basis of the conclusion was based upon the fiscal year 1985 budget submission which included the funds to begin the program. That was being debated during the budget process within the Department of Defense. Until that decision was made, there was no way to come before the Congress with an anticipated decision. It was not until that budget was completed, the Secretary of Defense made the decision, signed the policy, that I could come before the committee to present it.

Mr. NELSON. What was the reasoning behind the proposed financing package that subsequently has been abandoned? Is that correct?

Mr. ALDRIDGE. Yes.

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* The witness requests that this date be changed to read: February 7.

Mr. NELSON. It has been abandoned?

Mr. ALDRIDGE. It has been abandoned.

Mr. NELSON. What was the reason?

Mr. ALDRIDGE. I thought it was an excellent idea myself, but it apparently did not receive very much support.

What we were trying to do was to support a policy that has been supported by the President and now Congress of a commercial ELV program. If you are going to have a commercial ELV program, then you put the burden of proof and the burden of risk onto the contractor. So, that was a first objective, to have him take the money and develop the ELV through his own financing, with all the difficulties that creates, to make sure it works, and then we would pay for it just like we pay for the shuttle, a year ahead of the launch. So, it put the burden on the contractor for a commercial ELV. We thought that was what the objective that we were trying to pursue, a commercial venture.

It also minimized the cost to the Government because he didn't have to put any financing up front to pay for such a development. That was the contractor's risk, and we would pay for it just like we pay for the shuttle because our budget now includes shuttle ride cost for those two vehicles that we plan to procure ELV's.

So, it minimized the cost to the Government from an upfront point of view, and it put the burden of risk onto the contractor where it should be in a commercial venture, but unfortunately, that logic did not prevail. Congress, several committees in Congress, and the Office of Management and Budget disagreed with that approach. We were then directed to change it. Now, we are going back to a more conventional financing scheme in which the Department of Defense must provide the upfront cost to pay for the development and acquisition of those boosters in the years in which the funds are obligated. That is their plan of attack right now. We have, in the Defense Resources Board in the Department of Defense, that issue being debated. It requires the Department of Defense to come up with $300 million in fiscal year 1986 and requires some additional funds in fiscal year 1985.

If the Defense Resources Board concurs in that program, and the Department of Defense does in fact provide those funds in fiscal year 1986 which would be part of the President's fiscal year 1986 budget submission, we will ask the Congress for the reprogramming necessary to carry that program out in fiscal year 1985. It is a modest amount in 1985. That is our plan of attack at this point.

Mr. NELSON. Was part of that emphasis on commercial ELVs part of the background of your statement that Mr. MacKay had asked you about which was that to keep the United States a viable competitor with European ELVs?

Mr. ALDRIDGE. Yes, sir.

Mr. NELSON. So the theory is that in that financing arrangement, if you made it commercially financially viable for them to have a commercial ELV vehicle, then they were induced to go ahead and put the upfront money and produce this new vehicle which you would guarantee them that you were going to order 10.

Mr. ALDRIDGE. Yes, sir, that was the intent.

Mr. **Nelson**. What do you think about the NASA crowd that sort of reacts against that by saying here another arm of the U.S. Government is creating a competitor for the shuttle?

Mr. **Aldridge**. Mr. Nelson, I look at it differently than NASA does, as I mentioned before. I am not interested in flying the orbiter. I am interested in putting payloads in orbit, required essential payload in orbit, in the most efficient way possible. I think that should be the motivating factor behind any of our schemes, and the orbiter is one way to do it. An ELV is another way to do it, and I think the combination of both is the best way to do it. That is what I am proposing to do. My job is not determined by how many times we fly the orbiter. My job is to determine how many times we fly the orbiter reliably to put DOD payloads in orbit or how many times we fly the ELV to do that job. National security requirements, I think, are overwhelming, and I think we ought to develop a launch vehicle strategy based upon those requirements and based on both the orbiter and the ELV. That is what I am trying to pursue.

Mr. **Brown**. Will the gentleman yield?

Mr. **Nelson**. Yes, I will, in just one second, Mr. Brown.

I understand what you are saying, and if you say that you have to have for your security requirements, and everybody within that community buys off on that, that is one thing. But when you get into saying well, secondarily, we are going to do this commercial ELV policy and we have another purpose in here, then I think that is where you start to lose some folks.

Mr. **Aldridge**. No, sir. My purpose is to provide a complement to the orbiter. It so happens, in meeting that objective, we can solve a secondary purpose is to encourage commercial ELV builders into the business. By buying a certain number of them which I think we can clearly define a payload and payloads to launch on those, if that by buying into that 10 vehicle capability, the commercial firm, whoever is the winner, can build derivatives of that particular vehicle to compete with Arianne, so much the better, or compete with any other foreign market, so much the better. I think it then provides this country with a stronger space launch capability than would otherwise exist, and that is the objective we are trying to pursue.

Mr. **Nelson**. I yield to Mr. Brown, and then I will yield to Mr. MacKay.

Mr. **Brown**. It seems to me that you have a fairly substantial argument on the basis of national security considerations to have this ELV capability, but it seems to me that the most pressing of the national security considerations is the need for prompt reconstitutability of classified assets in near earth orbit rather than geosynchronous orbit launch capability. The shuttle cannot meet that requirement for prompt reconstituting of assets in the near earth orbit. Has that been a factor in your consideration and does the procurement of the 10 vehicles meet that need?

Mr. **Aldridge**. No, sir. It was a factor in our consideration, but it is not part of our current plan. The plan at this point in time is to only put those vehicles in geosynchronous orbit out of the Kennedy launch complex. Our plan out of Vandenberg is to continue to use the orbiter for those low altitude polar orbits that are essential.

Mr. **Brown**. Then you don't have a strategy for prompt reconstitutability of the near Earth assets?

Mr. **Aldridge**. Yes, sir. That is in a different area of classification from this particular hearing, but there is a plan for the survivability of our space assets through the spectrum of conflict that currently exists in which we are using not the fact of reconstitution but looking at improving the survivability of the satellites we currently have working on orbit and the ground stations that support it.

Mr. **Brown**. Well, I understand that aspect of it, but one aspect of total survivability of the system has to be reconstituting those that don't survive if all of the other things fail.

Mr. **Aldridge**. Sir, one of the factors that once you have an expendable launch vehicle capability, if in the future you decide that you can use that vehicle for reconstitution or for launching critical payloads that may not be the type that you would want to launch with a manned system, the ELV is capable of doing that. That is not part of our current plan, but yes, sir, it was a factor in the back of our mind when we made such a decision.

Mr. **Brown**. Also involved in that, of course, is the vulnerability of the launch sites themselves, so that a fully secure system would have to include alternate launch site capability.

Mr. **Aldridge**. Yes, sir, they would.

Mr. **Brown**. And that is a part of your planning also, I presume.

Mr. **Aldridge**. Yes, sir.

Mr. **Brown**. Thank you.

Mr. **MacKay**. Will the gentleman yield?

Mr. **Nelson**. I will. Let me just ask this quick question. Where did the policy of commercializing ELV's originate from? Did it come straight from the White House?

Mr. **Aldridge**. I think perhaps not any one place. The President's program is to pursue commercialization and get the Government out of pursuing those things which can be effectively pursued by commercial ventures. So, there is an overall policy that I think President Reagan is trying to pursue in that regard, commercialization for those Government functions that don't have to be performed by Government.

When looking for what areas might be associated with that particular plan, an idea was generated, and I don't know if it was from the White House or from the Department of Defense or Department of Transportation or Commerce, but a policy started working in to develop a commercial ELV, and there was a national security directive signed by the President which directed that that be done. It was NSDD 94.

Mr. **Nelson**. I yield to Mr. MacKay.

Mr. **MacKay**. Mr. Aldridge, I concede that it is valid for the Air Force to be concerned about the need for backup capability. I concede that. I think clearly you are doing your job.

It seems to me that the real issue is the question of whether you should not give NASA, in effect, a first refusal on this instead of developing an RFP which talks about mature technology and other things which sort of put NASA under the gun. Now, I have a copy of Mr. Beggs' letter of July 27 to you in which he says:

> Our studies at NASA indicate that by using a new system based on shuttle main engine technology, the Air Force could not only meet its near-term assured launch requirements, but also develop a vehicle that would exceed these requirements by perhaps double. Possibly more important, that vehicle would give the United States an important leg up on developing the heavy launch capabilities that will be needed for strategic defense and probably also for other military and civil use toward the end of the century.

Then, he said:

> Before you move further in the limited RFP process that has begun, I would urge that the Air Force and NASA sit down together and do a real zero-based evaluation of the various launch technology alternatives available to the country. On that basis, the RFP could be amended as I suggested in my letter of June 18, 1984. I believe this is consistent with your pledge to give shuttle-derived concepts an even-handed evaluation and, more important, it is consistent with the broader interests of the Nation in space leadership.

To me, the real issue is when you put mature technology wording and other wording in your RFP, are you not, in effect, limiting us to obsolete technology and could we not use this valid need that you have now as a way, as Mr. Beggs says, to get a leg up on what is clearly the next issue we all have to face? And how are you going to respond to that letter?

Mr. ALDRIDGE. I haven't seen the letter, so it is hard for me to respond to something I haven't seen yet, but let me just comment.

Mr. MACKAY. Well, I read part of it. What is your off-the-cuff reaction to that?

Mr. ALDRIDGE. First of all, I put shuttle-derived vehicles in mature launch capability. We have launched 10 shuttle flights, and the solid rocket boosters, which are part of that, are clearly mature technology. To the extent a commercial bidder wants to bid under the conditions of meeting our launch need dates, under those conditions he can bid. They have elected to do so because the cost is too expensive. The development cost to start over again is too much.

Now, let's talk about mature technology. The problem I see is that the technology that we ought to be pursuing with the most vigor is not in the booster; it is in the satellite that we are launching. The booster technology, to the extent that it is pursued, should be to get the cost of launch down and that is all. As long as we can keep the cost of launch down, that is what our objective should be.

The technology pursuit should be in the satellites that we are placing in orbit. We are not interested in how sophisticated the truck is. What we are interested in is the sophistication of the satellites in orbit.

Mr. MACKAY. But you should be interested in how sophisticated the truck is, because we have to pay for a new truck in about 10 years, and your own testimony said so. Why should we not pursue the most promising effort toward developing a new truck as long as we have to have one different from what we have now?

Mr. ALDRIDGE. Because I don't know what the requirements of that truck are in the timeframe you are talking about. I cannot sit here and say we ought to spend billions of dollars in the development of a new system, a new launch system, based upon requirements that I cannot yet define when, in fact, I have known requirements today that can be satisfied with boosters that do not require an extensive development program.

Mr. MACKAY. Thank you.

Mr. NELSON. Mr. Chairman, I would just say this in conclusion, that Mr. Beggs sat in that very seat yesterday and he, in essence, said that your RFP basically excludes them from the consideration, and it sounds like your comments right here have underscored that.

Mr. ALDRIDGE. No, sir. I have tried to make sure that our RFP does not exclude anyone from bidding that RFP that wants to meet the requirements. All we have specified in that RFP is a payload to orbit, size and weight, a date which we need it, and a launch complex which is nothing more defined than Kennedy Space Launch Center. I checked this morning before you came in just to verify that point because I am aware that Mr. Beggs said that we specified using the Titan launch complex and that is not true. We have not.

Mr. MACKAY. Would the gentleman yield for just one more question?

Mr. VOLKMER. Would you make it very brief because we have other members, too.

Mr. MACKAY. You have seen Mr. Beggs' letter of June 18, 1984?

Mr. ALDRIDGE. Yes, sir.

Mr. MACKAY. He suggested in that letter that the RFP be amended.

Mr. ALDRIDGE. It was amended, sir.

Mr. MACKAY. I see. Thank you.

Mr. VOLKMER. The Chair will recognize the gentleman from Washington.

Mr. CHANDLER. I won't ask any questions. I will just comment that I have a feeling that if you had come in here and suggested that we build a whole new generation of launch vehicles that this panel probably would have eaten you alive.

Thank you, Mr. Chairman.

Mr. VOLKMER. The gentleman from Virginia.

Mr. BATEMAN. Mr. Secretary, as I understand the thrust of your testimony and response to the questions, is that the Department of Defense has defined certain needs in our national security requirements which include some flexibility, some alternative of sole reliance upon the orbiter. I hope that I also get very clearly as the thrust of your testimony, that the Department of Defense is not interested in supplanting the orbiter or in nonuse of the orbiter and that throughout we can anticipate that the Department of Defense will, in fact, use the orbiter at all times that it is consistent with getting the mission of the Department of Defense accomplished.

Mr. ALDRIDGE. Yes, sir.

Mr. BATEMAN. Do I read you correctly on that?

Mr. ALDRIDGE. Yes, sir, absolutely.

Mr. BATEMAN. As you look further down the road at the presently undefined or illdefined requirements, I see references to the need for unmanned heavy lift vehicles of 100,000 to 250,000 pounds to orbit. Do we have any prospect here that developing that which is necessary to meet that requirement might be dovetailed with or a part of the effort that is going toward the manned space station and the heavy lift requirements that I would assume are involved in that program?

Mr. ALDRIDGE. Yes, sir. They could be dovetailed. I think what we have to do is try to be a little more definitive as to what those requirements are. 100,000 to 250,000 pounds is a pretty wide discrepancy in numbers and could result in a major difference in the type of vehicle that we might pursue.

One of the things that I think we ought to concern ourselves with is whatever we pursue for heavy lift, we should not throw away the billions of dollars of support structure we have already built for the existing shuttle. I think it would be ridiculous for us to go build a heavy lift vehicle system based upon a change in the launch complex or the payload change out rooms or any of the other things that we have invested so many hundreds, actually billions, of dollars in. We should take maximum use of the existing support base, and that require, rather than putting payloads on top of external tanks, it may in fact include things such as putting payloads on the side in place of the orbiter, for example. We don't want to change and have to go in and make huge pad modifications or support structure modifications to pay for such a thing. We ought to take advantage of our existing support base and the dollars that we have invested.

But we need to think about those things and look at what it will take to do that job. Right now, we don't have any designs of payloads or concepts that are necessary to carry out those kinds of studies.

Mr. BATEMAN. In your statement, you make reference to present plans to fly two satellites per year on the ELV between fiscal year 1989 and 1993. As we move into that timeframe, and assuming availability of orbiter and that it will do the job which needs to be done, would I be safe in assuming that a fallback position would be why use our ELV if, as we get to the time of launch or as we approach the time of launch, you have the space and you have the capability on the then-existing orbiter system?

Mr. ALDRIDGE. We certainly would have the flexibility to do that. However, in the pricing arrangements that we have made with NASA, we would have had therefore to pay for the ELV and also pay for the shuttle ride. That is something, as a taxpayer, I think I would object to having to pay for two rides for a single satellite. So, our intent is not to manifest that particular payload on the orbiter, but to pay for it on an ELV. In case of orbiter or ELV outage, we would have the capability to go back to the orbiter in case of emergency just as we would have the ability to go to another ELV if there was a problem with the orbiter.

Mr. VOLKMER. Will the gentleman yield on that just a moment?

Mr. BATEMAN. Yes, Mr. Chairman.

Mr. VOLKMER. Are you basically saying that you will be able to identify, within the near timeframe, the payloads that you will not be using the shuttle for but that you will be using an ELV for? In other words, you will be able to identify by, say, 1985 or 1986 those in this timeframe of 1989 to 1993 that you will be using an ELV for and therefore you can remove those from the manifest at this time?

Mr. ALDRIDGE. Yes, sir; our attempt is to identify two payloads which we have—let me put it less positively—we have identified two. We have tentatively identified two. We think those are the ones we are going to pursue to fly on the ELV, and those will not be shown as manifest on the shuttle in fiscal year 1988 and through 1993.

Mr. **Volkmer**. Then, in the event that you had to remove some from the manifest at a later time that were not intended to be flown on ELV's, would you be agreeable to paying or at least negotiating with NASA for the payment of some kind of a cost factor that they have gone through if you did remove one, reasonable cost for not using the shuttle when you said you were going to use the shuttle?

Mr. **Aldridge**. Mr. Chairman, I can't do that because that is illegal. I am committing you as a Congress to a future payment. I cannot commit——

Mr. **Volkmer**. Well, surely in the cost factor of the use of shuttle and the nonuse of shuttle you can make an agreement with NASA as to the payment.

Mr. **Aldridge**. That is the purpose of our MOA today is that we pay NASA 2 years in advance of the launch, because my understanding of it is that that is the negotiation because that is when they have to start committing funds to fly that particular orbiter.

Mr. **Volkmer**. Yes; but you are saying that the only ones basically, at least the two that you are not going to use, and you are going to be able to identify those far enough in advance that that won't cause any difficulty except it will reduce the number of payloads that go on the shuttle. Maybe they will be filled in by commercial or other means.

But what I am getting at is in the event that you would say that you are going to use a certain number and then one or two of those is removed within a 6-month or 8-month or a 10-month period, you don't believe it would be reasonable that you would pay, if they weren't able to replace that with a commercial or another payload, that it would be reasonable to expect you to pay part of those operational costs that NASA has incurred on the basis that you would be using it?

Mr. **Aldridge**. I believe we do that now, sir, in the timeframe you are talking about. I thought you were talking about in the 1988, 5 or 6 years into the future, manifesting and then pulling one of those rides off.

Mr. **Volkmer**. No, I am saying within a shorter timeframe.

Mr. **Aldridge**. I will have to get you the specifics, but I believe we do that. Once we remove——

Mr. **Volkmer**. Yes, but I mean the nonrefundable. Right now, if you remove, it is basically usable for the next year and you are already paying for it. I mean one that you are just going to forfeit some money.

Mr. **Aldridge**. Mr. Chairman, you are forcing me to go back to my original statement. You are penalizing us for success. If I don't need the shuttle ride based upon the fact that I don't need to launch the satellite because the existing satellites are living in orbit longer than they anticipated, once I had manifest it based upon an anticipated failure, then you are saying if I remove the shuttle or slip the shuttle ride into another year based upon the fact that I don't need to replace the satellite, then you are going to penalize me for success.

Mr. VOLKMER. In a way, if you don't, you are penalizing NASA.

Mr. ALDRIDGE. No, sir. The taxpayer will pick up the total cost whether I pay it or NASA pays it. The taxpayer is paying for the launch of the shuttle, and it doesn't make any difference whose budget it is in.

Mr. VOLKMER. But if the costs are chargeable, if by that timeframe, 1988, we are going to full costs chargeable——

Mr. ALDRIDGE. That is for foreign and commercial.

Mr. VOLKMER. That is right. Then you are going to put a part of that cost onto the commercial user and the other users. It is not necessarily just the taxpayers.

Mr. ALDRIDGE. Yes, sir. But, again, you are penalizing me for success. Every time I move a shuttle ride, it is not because I don't need to get to orbit. It is because normally I am being successful in my satellite designs and they are lasting longer and we are giving the incentive to the contractor to make that happen. I want them to last beyond the mean time to failure. I want them to last longer, and I give the incentive to the contractors to make them last longer. But I can't anticipate that ahead of time, so I have to manifest a ride on the shuttle based upon an anticipated failure date, and if there is any one reason why Mr. Beggs is saying we are coming off the shuttle, it is because we are being successful in our satellite designs. We don't need to launch as many, yet I still have to manifest it ahead of time.

Mr. VOLKMER. I will continue this at a later time because we are running out of time. I will give some time back to the gentleman from Virginia.

Mr. BATEMAN. Mr. Chairman, I have some observations I would like to make, but in deference to the other members of the committee, I will suspend and I will yield back my time.

Mr. NELSON. Would the gentleman yield to me just a minute?

Mr. BATEMAN. Yes, of course.

Mr. NELSON. Mr. Chairman, I am not going to prolong this, but I couldn't help but think, Mr. Secretary, as you were explaining part of your reason for making the announcement in February in which you said that you were looking at 160 hour turnaround time and you were looking at a five orbiter fleet. I couldn't help but think then we saw that the Air Force really didn't support that fifth orbiter from the standpoint of paying for it. I know all of your reasons because we have been through this privately many, many times. The thought just occurred to me that if the shuttle program had been an Air Force program rather than a NASA program, we would probably see a fleet right now of five, six, or seven orbiters and we probably wouldn't be going through all of this.

Here, again, we get this conflict between two agencies, and you are rather jealous of your prerogatives. I understand that. I understand that from an institutional standpoint. I understand that from a defense standpoint.

Mr. ALDRIDGE. Mr. Nelson, I disagree with you. I don't——

Mr. NELSON. Well, I hope you are right in your disagreement, but I have seen this agency competitiveness over and over again.

Mr. ALDRIDGE. I look at it—if the Air Force had been given the mission, which I think would have been wrong in the beginning, because the Air Force—it is the Department of Defense—will fly only one-third of the total number of missions, and that still is roughly the number that existed back in 1978 and it is roughly the number that exists today. I think if the President had given the mission to the Air Force in spite of the fact we only had one-third, I don't think we would have been sitting here arguing today. I think we would have had a mixture of launch vehicles in our stable that would have been roughly what we are asking for today, because the Air Force would have never bought shuttle only policy. Even then, they were arguing against it at the time.

Mr. VOLKMER. The gentleman from California, Mr. Lowery.

Mr. LOWERY. Thank you, Mr. Chairman. Mr. Aldridge, I am sorry I missed your testimony earlier.

Could you be more specific? You are looking at 10 vehicles through the 1993 timeframe?

Mr. ALDRIDGE. Yes, sir.

Mr. LOWERY. You mentioned a shuttle compatibility so Centaur upper stage and ELV.

Mr. ALDRIDGE. Yes, sir.

Mr. LOWERY. What are you looking for for other stages in that ELV?

Mr. ALDRIDGE. That is the only one, sir. The payloads that we are talking about launching require a Centaur with that ELV to place them in geosynchronous orbit.

Mr. LOWERY. And that is it? Launched on what, an Atlas or launched on——

Mr. ALDRIDGE. Sir, I am sorry.

Mr. LOWERY. Well, Centaur is an upper stage. What do you——

Mr. ALDRIDGE. We have a variety of possibilities. The proposals went out to the industry on July 20. They are expected back August 20. We anticipate that there will be a Titan variant with Centaur as an upper stage, an Atlas variant with Centaur as an upper stage, and, hopefully, possibly, a shuttle-derived vehicle with a Centaur upper stage.

Mr. LOWERY. OK. Shuttle derived using the shuttle engines basically——

Mr. ALDRIDGE. Yes, sir, and some core vehicle yet to be defined.

Mr. LOWERY. And then, beyond that, you are, as my colleague from Virginia was mentioning, you are looking at 100,000 to 250,000 pounds of lift capability?

Mr. ALDRIDGE. Yes, sir. That would exist after the 1993 period, in the mid-1990's that would be associated with requirements to be defined from space station or a strategic defense initiative or some other future requirements as yet undefined.

Mr. LOWERY. To my knowledge, there is no current ELV that has that capability, is there?

Mr. ALDRIDGE. No, sir. There is none.

Mr. LOWERY. An entirely new program.

Mr. ALDRIDGE. I wouldn't classify it necessarily as being entirely new. It might be a derivative of the current shuttle by removing the orbiter which is several hundred thousand pounds, 170,000, I think. I don't remember exactly the number, but you could place a large payload weight in low Earth orbit by removing the orbiter and placing a payload canister on the side to deliver it to low Earth orbit. That is one possibility.

Mr. LOWERY. What advantages were you, other that, I mean, I can understand the diversification. You don't want to necessarily rely upon one particular truck, if you will, but what are the advantages in the Air Force's mind of going to ELV's as opposed to a shuttle?

Mr. ALDRIDGE. A shuttle-derived vehicle? We are not foreclosing, in spite of many of the reports, a shuttle-derived vehicle competing with existing, upgraded ELV's. To the extent that they will meet the requirements of the dates that we have established for the payload launches, the payload weights, and the facilities, it could in fact compete under those conditions, and we are not trying to foreclose anyone who wants to bid under those conditions from competing. So, a shuttle-derived vehicle could do so to meet our near-term requirements.

It is my understanding from talking to the people who evaluate these technical proposals that the shuttle-derived vehicle to meet the near-term needs, which are defined as placing 10,000 pounds into geosynchronous orbit, is not necessarily the same vehicle you would design if you were heading for a longer-term, 100,000 to 250,000 pound vehicle, different type of vehicle, different class of vehicle altogether. So, while a shuttle-derived vehicle could in fact for the near-term, you would almost have to start all over again to build a larger vehicle for the future.

Mr. LOWERY. Was your reason for going to ELV's that the shuttle cannot meet this demand, you sequencing, the time that you need, launches to take place?

Mr. ALDRIDGE. It is no one reason you can point to. It is a whole series of reasons. We believe that the country need a national space launch capability that is very reliable and very robust, not dependent upon only four vehicles for the total access to space for this country. We have, in this rare instance, a technological lead over the Soviet Union, and we should have a launch capability to support that technological lead and not be in a position where an one event, a grounding of an orbiter, a failure, or some problem would deny us total access. We think a launch production base in the country existing of shuttles as well as ELV's is the way to go to provide that assured access.

Mr. LOWERY. Would there be weather conditions where an ELV could be launched where shuttle could not be? Is that a consideration?

Mr. ALDRIDGE. I think there are many conditions that you, under certain stress or risk, would launch an unmanned system before you would launch a manned system.

Mr. LOWERY. Were we to not move to that capability of an Air Force ELV, do you foresee an instance where the Air Force might have to launch a foreign-made ELV?

Mr. ALDRIDGE. I hope not. I don't believe we would. I can't rule it out. However, I think security problems would be insurmountable under those conditions of having to place these highly sensitive national security payloads on a foreign launch and depend upon foreign launch personnel to launch that vehicle. I think what we would do under those conditions is we would throw a heck of a lot of turmoil into the manifesting for the shuttle launch and make it work.

Mr. LOWERY. Thank you, Mr. Chairman.

Mr. VOLKMER. The gentleman from Pennsylvania.

Mr. WALKER. I have no questions at this time, Mr. Chairman.

Mr. VOLKMER. I want to thank you very much, Secretary Aldridge and the others for being here. It has been very helpful.

We may have other questions I will submit in writing, and if you will respond to those, we will appreciate it.

Mr. ALDRIDGE. Yes, sir.

Mr. VOLKMER. I want to thank you for being here today. I hope this all works out satisfactorily to everyone.

Mr. ALDRIDGE. Thank you, Mr. Chairman.

Mr. VOLKMER. Personally, I have some concerns. I think I have expressed those.

Mr. ALDRIDGE. Yes, sir.

[Answers to written questions for Mr. Aldridge follow:]

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

HEARING TO REVIEW SPACE SHUTTLE REQUIREMENTS, OPERATIONS AND FUTURE PLANS

August 1, 1984

Additional Questions for Sec. Aldridge

1. a. How strong of a requirement does the Air Force have for the Vandenberg Shuttle launch site?

   b. Given this requirement, how strong is the Air Force's commitment to the long term operation and support for the Vandenberg launch site?

2. From a DOD perspective, what are the major inadequacies of the Shuttle in satisfying DOD needs and what changes can and should be made to the Shuttle and its operations that would overcome these inadequacies?

3. As the Shuttle matures in its operation phase, future management and ownership options for the Shuttle will be considered by the Congress. Alternatives that have been suggested include:

   a. Retaining operational control of the Shuttle within NASA;

   b. Turning the Shuttle over to the private sector (privatization);

   c. Establishing a quasi-government organization to operate the Shuttle; and

   d. Splitting the Shuttle into two fleets, one operated by NASA, the other operated by the Air Force.

   What is your assessment of each of these options? Which would DOD most favor and why?

4. What would be your response to a proposal that DOD share some of the Shuttle's fixed operating costs? Should NASA continue to fund all fixed operating costs for the Shuttle and, if so, why?

5. The Air Force has 53 Titan II ICBMs in its inventory that are being retired from strategic service. Like earlier retired Atlas ICBMs, these missiles could be converted into launch vehicles for some military payloads such as navigation satellites and weather satellites.

   - What is the Air Force's current plan for using retired Titan II ICBMs as launch vehicles?

   - If there are no current plans to use retired Titan II ICBMs as launch vehicles, what is the likelihood that such plans may be develped within the next 5 to 6 years?

   - Could any of these vehicles be modified to meet the requirements of your current RFP?

Additional Questions from Mr. MacKay

6. Does the Air Force have any plan to acquire more than two ELVs per year or more than a total of 10?

7. The sentiment which has been expressed by potential bidders on the ELV seems to be that the Air Force has decided to go with Titan. This makes it foolish for other companies to spend money to prepare a proposal. The request for proposal (RFP) seemed to confirm that belief. What is the Air Force doing to dispell this feeling and encourage true "competition" in the bidding?

8. What is the full legal basis for your statement that the Air Force cannot legally accept a bid from NASA? Does NASA concur?

9. Is the Air Force willing to pay any money premium for either performance above your RFP specifications or the capacity to grow to greater specifications without redesign?

10. Do you believe the Air Force has any responsibility to make procurement decisions based on the "National Interest" as compared to a tightly defined "National Security Interest"?

11. Does the MX missile offer any ELV opportunities for the Air Force?

12. Has the Air Force ever had a delay in placing a payload in space because of a Titan failure? An Atlas failure? An upper stage failure? Why should the Shuttle be held to a tighter standard?

13. Is it not true that even with ELVs, satellites are designed for a particular vehicle and are not easily transferred from one to another (even from one Titan to another)?

14. Are Titan launch facilities any more secure than Shuttle facilities?

Additional Minority Questions

15. The Shuttle Utilization Task Force noted the complexity and time involved in shuttle integration of DOD payloads. Is this problem at the link between NASA and the Air Force point-of-contact?

16. Does the Air Force foresee more than one or two payloads per year for the backup ElV's?

Air Force Requirement for Vandenberg Shuttle Launch Site

QUESTION: How strong of a requirement does the Air Force have for the Vandenberg Shuttle launch site?

ANSWER: The Air Force has a long standing requirement for a Vandenberg AFB launch capability that will not change in the foreseeable future. Vandenberg AFB provides the only national capability to attain the high inclination and polar orbits required for critical payloads. Our approved Mission Model currently extends through 1992, and includes Vandenberg launches throughout that time frame. The requirement for the Vandenberg Shuttle launch site has been validated and remains strong.

Air Force Commitment to Vandenberg

QUESTION: Given this requirement, how strong is the Air Force's commitment to the long term operation and support for the Vandenberg launch site?

ANSWER: The Air Force is committed to the long term operation and support for the Vandenberg Launch and Landing Site (VLS). The FY 85 President's Budget contains funds to operate and maintain the VLS. We have every intention of continuing the funding required to operate the VLS throughout the life of the program.

Space Shuttle Inadequacies

QUESTION: From a DOD perspective, what are the major inadequacies of the Shuttle in satisfying DOD needs and what changes can and should be made to the Shuttle and its operations that would overcome these inadequacies?

ANSWER: At this time, all DOD performance requirements are being met for missions to be launched from the Kennedy Space Center. For future launches from Vandenberg AFB, the majority of our requirements are being met. However, we have some concerns with lift capability which we are working closely with NASA to solve. Upgrading the Space Shuttle Main Engines to the 109% performance level, and using lightweight filament wound case solid rocket boosters will solve most of the performance shortfalls.

Specific STS shortfalls listed below are being addressed for resolution by joint Air Force/NASA groups on a continuing basis: payload lift capability from the Vandenberg AFB launch site, orbiter bay cleanliness, guidance and navigation accuracy and cross range capability. Although Kennedy Space Center launched vehicles have sufficient payload lift capability, Vandenberg AFB launched vehicles do not. NASA has presented a plan to increase the payload lift capability at VAFB to meet DOD requirements. The orbiter bay cleanliness is a continuing problem and no easy fix has been identified. Initiatives are in the work to remedy the on-orbit guidance and navigation accuracy by installing Global Positioning System (GPS) receivers. Due to thermal protection system inadequacies, the orbiters cannot meet cross range requirements. This limitation results in the capability to only fly approximately 800 nm of cross range versus a planned capability of 1100 nm. This limited cross range, coupled with performance shortfalls, forces negotiations for the use of Hao (French) and Easter Island (Chilean) as Pacific abort landing sites. Even if the negotiations are successful, there is still no guarantee that the sites will always be available to support launch aborts. Since the security and safety of highly classified and high value hardware could be compromised, the actual use of these sites creates great DOD concern. In addition, serious logistic support problems are incurred if overseas abort sites are utilized. To correct these deficiencies NASA should pursue all prudent measures to reduce the likelihood of non-CONUS landing sites by increasing the cross range capability and shuttle performance to alleviate the need for foreign controlled abort sites. Specific plans and programs are needed to ensure a means of Shuttle and payload recovery are available should foreign landings occur. These programs should include additional Shuttle Carrier Aircraft (SCA) and an in-flight refueling capability for the SCA.

MANAGEMENT AND OWNERSHIP OF THE SHUTTLE

QUESTION: As the Shuttle matures in its operational phase, future management and ownership options for the Shuttle will be considered by the Congress. Alternatives that have been suggested include:

a. Retaining operational control of the Shuttle within NASA;

b. Turning the Shuttle over to the private sector (privatization);

c. Establishing a quasi-government organization to operate the Shuttle; and

d. Splitting the Shuttle into two fleets, one operated by NASA, the other operated by the Air Force.

What is your assessment of each of these options? Which would DOD most favor and why?

ANSWER: Since the majority of our payloads will fly on the Space Shuttle, we are very interested in any changes which might affect management and operations of the Space Transportation System (STS). At this time, we favor maintaining the current system. Currently, a DOD study is under way, under the auspices of the Defense Space Operations Committee (DSOC), evaluating Shuttle management concepts. We anticipate an evaluation of each of these alternatives by the end of September. After the study is complete, the results will be presented to NASA with DOD recommendations.

SHARING OF THE SHUTTLE'S FIXED OPERATING COSTS

QUESTION: What would be your response to a proposal that DOD share some of the Shuttle's fixed operating costs? Should NASA continue to fund all fixed operating costs for the Shuttle and, if so, Why?

ANSWER: The Air Force already shares a fair portion of the Shuttle's fixed operating costs. The AF/NASA Memorandum of Agreement on Reimbursement of Launch and Associated Services for use of the Space Shuttle (signed by the NASA Administrator and the Secretary of the Air Force, 1 Feb 1983) provides for an equitable sharing of costs for DOD use of the Space Shuttle. DOD maintains and provides launch services for all payloads (including NASA and commercial) that are to be launched from Vandenberg AFB, California. Further, the DOD pays to NASA an orbital flight charge (OFC) for launch services (external tank, solid rocket boosters, and refurbished Space Shuttle main engines) for each flight whether at Kennedy Space Center or Vandenberg. And finally, DOD pays the full cost of designing, acquiring, installing, operating and refurbishing all security measures and systems required at NASA facilities to protect DOD classified missions. NASA in turn provides launch services at Kennedy Space Center as well as overall management of the Space Shuttle. DOD's commitment to the STS through the FYDP amounts to more than $14 billion. This $14 billion is 30% of a total national investment of $47 billion (thru FY 89). Since we fly approximately 30% of the missions, we have and continue to pay our fair share. On a per use basis, DOD has always paid a fair share of Shuttle fixed operating costs. Further, the U.S. taxpayer pays the cost of STS flights, regardless of whose budget it is in. If the DOD is to pay an additional percentage of the cost, that amount should be transferred from the NASA budget to the Air Force budget.

USE OF TITAN II ICBMs AS SPACE LAUNCH VEHICLES

QUESTION: The Air Force has 53 Titan II ICBMs in its inventory that are being retired from strategic service. Like earlier retired Atlas ICBMs, these missiles could be converted into launch vehicles for some military payloads such as navigation satellites and weather satellites.

- What is the Air Force's current plan for using retired Titan II ICBMs as launch vehicles?
- If there are no current plans to use retired Titan II ICBMs as launch vehicles, what is the likelihood that such plans may be developed within the next 5 to 6 years?
- Could any of these vehicles be modified to meet the requirements of your current RFP?

ANSWER: Experience gained from the success of the Atlas launch vehicle system indicates that the Titan II ICBM is a vital resource which could provide an outstanding opportunity for use as a space launch vehicle. To that end, the Air Force places high value in the Titan II system, and is deactivating the fleet through a meticulous process of careful handling, thorough documentation, propellant offload and storage, and booster storage in a secure facility at Norton AFB, CA.

However, the Titan II ICBM modified as a space launch vehicle would only have a capability placing less than a 1,000 lb satellite into geosynchronous orbit, which is far below the ELV requirement of 10,000 lbs to geosynchronous. Studies show the Titan II to be capable of launching the smaller, polar orbit meteorological satellites, such as the Defense Meteorological Satellite Program (DMSP) and the National Oceanographic Atmospheric Administration (NOAA) Satellites.

The Air Force is continuing its studies of using Titan IIs for launching smaller satellites, and decisions will be made during DOD's internal budget formulation process this year.

AF LIMITATION OF ELVs

QUESTION: Does the Air Force have any plan to acquire more than two ELVs per year or more than a total of 10?

ANSWER: The Air Force has no plan to acquire more than ten expendable launch vehicles provided no unforeseen contingencies occur in the future. The Air Force's intent is to procure ten vehicles, which will satisfy the near-term DOD requirements for providing a complementary launch capability in the timeframe when no current ELV production exists and no further STS orbiter production will be available.

COMPETITION IN BIDDING THE ELV

QUESTION: The sentiment which has been expressed by potential bidders on the ELV seems to be that the Air Force has decided to go with Titan. This makes it foolish for other companies to spend money to prepare a proposal. The request for proposal (RFP) seemed to confirm that belief. What is the Air Force doing to dispel this feeling and encourage true "competition" in the bidding?

ANSWER: The Air Force has made it very clear through discussions with industry, bidders conferences, and other procedures available to the acquisition process that this is a open competition to satisfy a well defined and valid DOD requirement. Bidder and NASA suggestions to ensure equitable treatment of potential competitors were employed in every applicable instance. The assertions that the RFP is geared for Titan are incorrect. It is the Air Force's view that at least three contractors have the capability to build an ELV under the parameters called for in the RFP; two of the three contractors have expressed intentions to submit bids, and the third contractor will probably assist NASA in submitting its proposals. Neither the prospective contractors nor NASA have expressed any formal concerns that the RFP shows bias towards Titan. In summary, it is very much in the Air Force interest to have an equal and strong competition for the complementary ELV's. The Air Force believes the ELV request for proposal will allow equal consideration for all candidate systems.

TREATMENT OF NASA PROPOSAL

QUESTION: What is the full legal basis for your statement that the Air Force cannot legally accept a bid from NASA? Does NASA concur?

ANSWER: To state that we "cannot legally accept a bid from NASA" is not accurate and is mixing two distinct concepts -- Government performance and contractor performance. If we were to obtain the launch services from NASA, it would mean that we had determined not to obtain them by contract. Several regulations are relevant in this context. These regulations are OMB Circular A-76, dated Aug 4, 1983, and Federal Acquisition (FAR) Section Seven, part three. Circular A-76, paragraph 4.a. states, "In the process of governing, the Government should not compete with its citizens.... In recognition of this principle, it has been and continues to be the general policy of the Government to rely on commercial sources to supply the products and services the Government needs." The DOD FAR Supplement at 17.502(b) further provides that government agencies not be placed "in direct competition with commercial sources."

Given the above, the Air Force will compare it as a government alternative to the commercial winner.

GROWTH CAPABILITY

QUESTION: Is the Air Force willing to pay any money premium for either performance above your RFP specifications or the capacity to grow to greater specifications without redesign?

ANSWER: The specifications called for in the complementary ELV RFP reflect the volume and weight requirements to support DOD's most demanding geosynchronous satellite programs. While we have initiated studies to define requirements and concepts for future heavy lift unmanned launch vehicles, the DOD has no current plans to acquire geosynchronous satellites weighing more than 10,000 lbs for the next decade. To that end, the Air Force is not willing to spend a premium for an enhanced capability it does not need.

NATIONAL SECURITY INTEREST

QUESTION: Do you believe the Air Force has any responsibility to make procurement decisions based on the "National Interest" as compared to a tightly defined "National Security Interest"?

ANSWER: We believe national security interests are consistent with national interest.

MX AS AN ELV?

QUESTION: Does the MX missile offer any ELV opportunities for the Air Force?

ANSWER: The MX is a solid propelled missile which has little, if any, utility as a space launch vehicle for current DOD satellites. It has a capability to launch a 2,000 lb satellite into low earth, polar orbits. However, no DOD satellite is designed to withstand the severe launch environment vibrations and acoustics driven by the all-solid MX booster. As a result, substantial satellite redesigns would be needed to allow for compatibility with MX.

LAUNCH DELAYS

QUESTION: Has the Air Force ever had a delay in placing a payload in space because of a Titan failure? An Atlas failure? An upper stage failure? Why should the Shuttle be held to a tighter standard?

ANSWER: The Air Force has had delays in placing payloads in space due to Titan, Atlas, and upper stage failures. Placing total reliance on the Shuttle, however, poses significant departures from the ELV era.

In the Shuttle-only era, the DOD and the nation are totally reliant on a limited orbiter fleet with the possibility of no continuing production base. The loss of one orbiter reduces the nation's total launch capability by 25%, assuming a four orbiter fleet. Further, the nation would need to operate with a degraded launch capability for 4-5 years until the lost orbiter could be replaced. With ELV's, failed booster's can be replenished by a continuing production line.

There is a high probability that a Shuttle failure could result in a fleet grounding for an indefinite period of time. In prior years we had a series of different ELV systems, and the grounding of one, (e.g Atlas) did not affect the operation of the Titan launch vehicle system, even though it may have effected specific payloads.

The Shuttle is a man-rated system. It is cearly one thing to commit an unmanned vehicle to launch to satisfy a pressing satellite launch need, and yet another when a man is aboard.

The above Shuttle scenarios are real, and clearly reflect a departure from the ELV era. This departure requires the nation, not necessarily NASA or DOD, to hold the Shuttle to tighter standard than ELVs.

DUAL-COMPATIBILITY

QUESTION: Is it not true that even with ELVs, satellites are designed for a particular vehicle and are not easily transferred from one to another (even from one Titan to another)?

ANSWER: Until recently, the nation has been producing several families of different ELV configurations, e.g., Atlas, Delta, Scout, & Titan. Each ELV family could produce varying models of boosters as the demand arose. When a satellite program selected a certain booster system, the satellite would normally prepare the integration tasks necessary for compatibility with that booster system alone. If the integration tasks are complete for a certain booster/satellite "stack", it is not an easy task to transfer that satellite to a different booster system (e.g., Delta to Atlas). Transferring a satellite from one Titan to another similar Titan, however, is not a difficult process.

In the case of the Complementary ELV, selected satellite programs will be made "compatible" with the ELV and the Shuttle to assure an access to space. Although compatibility carries an added cost, that cost is money well spent for assuring an access to space for critical satellites.

SECURITY OF LAUNCH FACILITIES

QUESTION: Are Titan launch facilities any more secure than Shuttle facilities?

ANSWER: A strong effort has been made to insure that DOD security requirements can be equally met at both Titan and Shuttle facilities.

Shuttle Integration of DOD Payloads

QUESTION: The Shuttle Utilization Task Force noted the complexity and time involved in shuttle integration of DOD payloads. Is this problem at the link between NASA and the Air Force point-of-contact?

ANSWER: No. Because DOD payloads are more complex than commercial or foreign payloads and require certain unique security activities, it may take longer to ensure that all safety, security, handling and payload unique requirements are met. There are no problems introduced by the Air Force and NASA points of contact.

LAUNCH RATE OF ELVs

QUESTION: Does the Air Force foresee more than one or two payloads per year for the backup ELVs?

ANSWER: The Air Force plan is to launch the ELVs at a rate of approximately two per year for five years as launch requirements dictate. The remaining DOD payloads will be launched on Shuttle.

Mr. **Volkmer**. At this time, we will proceed with the hearing, and we have the panel of all the Center directors. There is Jerry Griffin, Mr. Lucas, Mr. Smith, and Mr. Hearth. They may all come up and be at the table. We will hear from them in the order their names are written, and were read. After you all present your statements, we will proceed with questioning.

All of your statements will be made a part of the record in total, and you may either summarize the statement or review it in full, however you so desire.

I have to step outside to make an urgent phone call but I will return in a few minutes, and as soon as we get settled, Jerry, you can proceed. Go ahead.

Mr. **Griffin**. All right, sir.

STATEMENT OF GERALD D. GRIFFIN, DIRECTOR, LYNDON B. JOHNSON SPACE CENTER; ACCOMPANIED BY GLYNN S. LUNNEY

Mr. **Griffin**. Mr. Chairman and distinguished members of the subcommittee, it is a pleasure to be back to talk to you. I roamed these halls for about 3 years about 10 years ago, and I know Mr. Brown and I had a long and successful relationship. Some of you have come since I was here last, but it is a real pleasure to be here today.

I would like to use two viewgraphs, and I will summarize my statement and submit the entire statement for the record. If I could have the first viewgraph (Figure 1) please.

When we conceived of the shuttle in the early 1970's, we didn't think of it as merely a replacement for the expendable launch vehicles, but as a system which would provide the Nation a capability to develop and exploit a variety of new technologies. Everything we have been able to do to date convinces me that the original concept was fundamentally correct. I think of the evolution of the system in order to lay the context of where we are today in five phases.

This chart, if we could get that focused a little bit, shows the first three phases. I think it is provided in the record.

The orbital flight test was the first phase and ended after the fourth flight. The objective was to certify the adequacy of the basic shuttle design; and, indeed, it did that. We are continuing to collect certain performance data and we will for about another year to complete the characterization of some performance parameters. As you well know, there have been some problems along the way, and we have several design fixes in work today. None of these problems have been a threat to safety, but operational productivity and cost considerations require some additional modification.

The second phase, which we are in now, is what I call payload capability demonstration. The retrieval and repair of the Solar Max spacecraft, the delivery and deployment of upper stages and the successful spacelab sortie mission with its multiple scientific objectives all illustrate aspects of the STS capability to meet the requirements of many different users. Two payload accommodation capabilities that have proved particularly rewarding are the orbiter middeck experiment accommodations and the get away special, sometimes called GAS Cans. Each of the missions we have flown to date during this second phase has been significant because of its pathfinder for future missions of that particular type.

We are about to enter the third phase which I have called systems deployment. It is the completion of the acquisition of the operational assets which will be the primary activity through the remainder of the 1980's. Orbiter 102, Columbia, will be delivered from its modification to remove the flight test configuration, such as the ejection seat and other items. It will remain unique, however, in that it is significantly heavier and the only orbiter instrumented as a high performance aeronautical research vehicle. OV-104, Atlantis, will be delivered early in 1985, and the current fleet commitment will then be in the field. During this period, we are also bringing on a number of facilities at Kennedy, Vandenberg Air Force Base, and at Colorado Springs which will complete the systems deployment phase. During this phase, we will also complete the deployment of the tracking and data relay satellite system and reconfigure the tracking networks to the STS missions.

The Centaur will be used in May 1986 to perform two very demanding planetary missions. Orbital Systems Corp. will introduce its transfer orbit stage and McDonnell Douglas plans to add its second stage to the available inventory of upper stages.

We will also have available the STS lift performance improvements from the filament wound case in the solid rocket booster and the SSME, the main engine improved engine life projects.

I would like to say a special word because I know the subcommittee is interested here at this point on logistics. During this period, in this third period, the logistics system to sustain continued operations for the orbiters will complete its initial inventory layup and the equipping of repair facilities. Our ability to support the flight manifest of the operational phase of the shuttle is based on our repair capability that will affort the most rapid turnaround of orbiters. Three levels of repair capability have been established. We call those organizational, intermediate, and depot.

The organizational level of repair is defined as that repair that can be accomplished basically on the launch pad—I am sorry—on the vehicle within the orbiter preparation flow at Kennedy Space Center or at Vandenberg later. The intermediate level of repair requiring moderate skill levels and simple support equipment will be at a designated workshop area at Kennedy or later, Vandenberg. The third level of repair which requires high skill levels and complex support equipment will be accomplished at a preselected depot such as the Air Force Logistic Command repair facility, a unique repair location established within one of the NASA centers, a consolidated commercial depot, and/or, in some cases, the original equipment manufacturer.

I want the subcommittee to know that our plan is to have a full up operational repair system in place by September 1988.

The next phase, and if you will give me the next chart (figure 2), please, the fourth phase, as I see this, is what I have called the steady STS steady state phase. It will occur steadily through the 1980's and reach an expected steady state rate of 24 flights per year, and that is shown at the top of the chart in the rather tan color, an envelop of various activities.

For this era, we must develop the surge capability in both hardware turnaround processing and in software development and crew training so that we can accommodate the inevitable last minute problems that we will occasionally encounter in the STS, its payloads, or some of our operational facilities.

In our initial efforts, for instance, cargo manifesting and flight implementation was an 18-month process just to get onto the orbiter. Since mid-1983, we have reduced that cycle to 9 months for cargoes similar to those we have flown before, and we believe that we can achieve a 6-month planning cycle as the number of experienced crews and users recycling through the planning and integration system grows. This is a significant savings since it means that we can handle three times as many flights in some stage of planning or execution with constant staff level.

Because there has been so much attention, and we have heard at this hearing as well, focused on turnaround time and its relation to flight rate, I want to point out that launch window constraints imposed by the payload and by STS operation considerations limit the actual flight rate to some fraction of that normally available as a function of turnaround time. Launch window constraints derive from such considerations as the lighting conditions a communication satellite desires for its deployment; the lighting and weather conditions needed for an STS abort landing site; the orbital conditions which define the minimum energy trajectory to a particular planet; and something like the phasing relationships required for a rendezvous with the satellite to be serviced or recovered. To achieve a given flight rate and a high confidence in meeting schedule commitments when all these constraints are imposed requires planned flow times and resources that would provide a higher flight rate if there were no launch window constraints. Let me simply throw in here that it is a little bit, rather than when we talk 24 flights per year, rather than launching on the 1st and the 15th, we quite often have requirements to launch on the 1st and the 6th. Therefore, we cannot level our requirements. I will say more about that later.

During this steady state phase, I expect that we will begin to see significant numbers of commercial venture prototypes comparable to the CFES, the continuous flow electrophoresis system, and what we call MLR, the monodisperse latex reactor that we are now flying. I believe this will occur because the frequency of flight opportunities will make experimental process and product development more effective and economical and because the prospect of space station availability in the early 1990's will assure lower cost production quantity opportunities for successful developments between now and then. This provides a unique opportunity for U.S. industry to position itself for the space manufacturing era of the 1990's.

The last phase on here is the darker tan on the chart. It is what I have called the combined STS space station operations. It is the final phase, at least, in our planning horizon right now.

The STS and space station are complementary systems as was illustrated in our original studies in the early 1970's and has been reaffirmed by the mission analysis studies conducted by the space station task force last year. That is illustrated, as I said, on this chart, in this area of overlap between STS unique activities and the space station unique activities.

The station enhances the effectiveness of STS because, as a depot, it provides a place to store cargo on orbit. This permits an improved load factor for the STS. Since the station is accessible every day, it allows the overall system to move many of the launch window constraints that I mentioned previously to the station which enhances the shuttle Earth to orbit flight rate capability.

In the evolution of the STS and in the development of the space station, we need to keep in mind that there is only one set of customers for both the STS and the station, and they will get to the station aboard the shuttle. We need to assure the customers that there will be standard design practices, for example, safety requirements, and standard interface provisions. If we do not achieve such standards, they will create cost and schedule barriers that will inhibit the growth of space station activities.

It seems likely to me, too, that there can be some hardware commonality to the mutual benefit of both programs.

In the early 1990's when the space station will buy its subsystems and components, many of the counterpart STS components will no longer be available because the solid state devices on which they were designed will no longer be produced. For such items, a common procurement may be both practical and cost effective as a way of upgrading the STS subsystems and providing a common logistics infrastructure for the space station and the STS in the mid-1990's.

Charts off, please.

These five phases I have described each have a unique focus for emphasis. What I would like to address now are the management challenges I think are common to all of them.

The basic system design of the STS is proven, and we must assure that future changes are limited to the upgrades necessary to facilitate turnaround cost of ownership. Process control is the key to our operational success. With the design fixed, we can in some areas relax operational procedures and checks, but in others we must remain as vigilant as we were before STS-1. It will take considered judgment to determine what procedural changes we can make without compromising quality, schedule, assurance, or safety.

The common thread in all phases of the STS program is to manage risk. We cannot be so cautious that cost and schedule assurance are jeopardized nor can we afford to be casual when dealing with such a complex high energy system.

Let me conclude my remarks by summarizing our current efforts to streamline the STS organization and management structure. At the Johnson Space Center, we have three major activities in progress, and I will describe each of them.

First, we plan to consolidate some of the contracts that currently support our operations directorate into a single contract. Our plans call for the competition to occur in early 1985, and the winner to be in place early in 1986. We believe the net effect of this action will be to reduce the civil service staff requirements for operations support and provide a functional structure for the contractor in which he can achieve economies in redeploying staff while maintaining a capability to surge when circumstances warrant. The civil service staff made available by this consolidation will bring critical skills to help us meet our Space Station planning and development commitments. Second, a similar consolidations plan for the flight equipment processing contract. This contract will provide for maintenance, flight preparation, and inventory control of the many items of crew and orbiter equipment which fly as a function of mission objectives, crew numbers, and the sizes of the crew. We anticipate economies in this consolidation by bringing the activity into a single facility and by the elimination of redundant functions among the several contractors now processing various items. There will also be a reduced civil service requirement in these areas, and these personnel will move to the space station functional areas.

Finally, we are examining the structure of the National Space Transportation System Program office and the JSC space shuttle project offices. With the delivery of 104 in sight, we plan to examine the relative roles of these two offices, focusing on consolidation and streamlining of functions. In the course of this examination, we will also study when and how a number of functions may be transferred to KSC. We have already begun that study with folks at KSC. I imagine this will be a phased process with some activity beginning as this year ends, but some functions must remain at JSC until the appropriate significant event occurs, for instance, the first flight of the Centaur upper stage. The design and development experience released by these actions will be made available to the space station as well.

This completes my prepared remarks and I am prepared to respond to any questions at the proper time, Mr. Chairman.

[The prepared statement of Mr. Griffin follows:]

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS
August 1, 1984

Statement of

Mr. Gerald D. Griffin
Director, Lyndon B. Johnson Space Center

National Aeronautics and Space Administration

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman, Distinguished Members of the Subcommittee --

I am pleased to be here and to participate in this panel. In this prepared statement, I'll endeavor to respond to the questions you posed in your invitation to me, and to summarize my own thoughts on the current status and future evolution of the Space Transportation System.

When we conceived of the Shuttle in the early 1970's, we did not think of it as merely a replacement for the expendable launch vehicles, but as a system which would provide the nation a capability to develop and exploit a variety of new technologies and space activities through the end of the century. Everything we have been able to do to date convinces me that the original concept was fundamentally correct. I now think of the evolution of the system in five phases:

- Orbital Flight Test -- was the first phase, and the objective was to certify the adequacy of the basic Shuttle design. It was completed on STS-4 with few surprises. We will continue to collect certain performance data for another year to complete the characterization of some performance parameters. As you well know, there have been problems with the waste management system, the landing gear wheel and brake assembly and the auxiliary power unit. Each of these systems has design fixes in work. None is a threat to safety, but operational productivity and cost considerations require the redesigns.
- Payload Capability Demonstration -- is the second phase and is characterized by the activities in which we are currently engaged. The retrieval and repair of the Solar

Maximum spacecraft, the delivery and deployment of upper stages and the successful Spacelab sortie mission with its multiple scientific objectives all illustrate aspects of the STS capability to meet the requirements of many different users. Two payload accommodation capabilities that have proved particularly rewarding are the Orbiter mid-deck experiment accommodations and the Get Away Special Containers (GAS Cans). Each of the missions we have flown to date has been significant because it is the "pathfinder" for future missions of that particular type. We have several additional pathfinders to fly over the next two years, most notably the Galileo and ISPM planetary missions and the polar orbit missions from Vandenberg AFB, California.

o System Deployment -- the third phase, will be the primary activity through the remainder of the 1980's. Orbiter 102, Columbia, will be delivered from its modification to remove the flight test configuration items such as the ejection seats and to make its operational configuration compatible with the other vehicles. It will remain unique in that it is the only Orbiter instrumented as a high-performance aeronautical research vehicle. OV-104, Atlantis, will be delivered April 1985, and the current fleet commitment will then be in the field. A number of facilities at KSC, Vandenberg and Colorado Springs will come online in the late 1980's or early 1990's. With qualification of the IUS fix to the techroll seal, we can complete deployment of the Tracking and Data Relay Satellite (TDRS) and reconfigure the tracking network.

A number of additional upper stages will be introduced to operations. The Centaur will be used in May 1986 to perform two demanding planetary missions. Orbital Systems Corporation will introduce its Transfer Orbit Stage, and Astrotech International plans to add its Delta Transfer Stage to the available inventory of upper stages.

We will also have available the STS performance improvements from the Filament Wound Case for the Solid Rocket Booster and the SSME improved engine life projects.

During this period, the logistic system to sustain continued operations for the Orbiters will complete its initial inventory layin and the equipping of repair facilities. Cost incentive contracting has been implemented, and award fees will be based on performance. In order to better understand the actual cost of the hardware, the supplier will be required to break out separately the support costs such as overhead. Preparations are underway to "buy-out" the Orbiter components from vendors who are no longer manufacturing the hardware.

Our ability to support the flight manifest in the operational era of the Shuttle is based on a repair capability that will afford the most rapid turnaround of Orbiters. Three levels of repair capability have been established -- organizational, intermediate, and depot. The organizational level repair is defined as that repair that can be accomplished basically on the vehicle within the Orbiter preparation flow such as the OPF, VAB, and/or Launch Pad at either KSC or VAFB. The intermediate level of repair requiring moderate skill levels and simple support equipment will be at a designated workshop area at KSC. The third level of repair which requires high skill levels and complex support equipment will be accomplished at a depot such as an Air Logistic Command (ALC) repair facility, a unique repair facility established within one of the NASA centers, a consolidated commercial depot, and/or in some cases the original equipment manufacturer (OEM). Our plan is to have a full-up operational repair system in place by September, 1988.

o Flight Rate Buildup -- the fourth phase, will occur steadily through the 1980's and reach an expected steady state of 24 flights per year. For this era, we must develop the surge capability in both hardware turnaround processing and in software development and crew training so that we can accommodate to the inevitable last minute problems that we will occasionally encounter in either the STS or its payloads. We are making significant progress in both of these areas.

In our initial efforts, cargo manifesting and flight implementation were an 18 month process. Since mid-1983, we have reduced that cycle to nine months and believe that we can achieve a six month planning cycle as the number of experienced crews and users recycling through the planning and integration system grows. This is a significant savings since it means that we handle three times as many flights in some stage of planning or execution with a constant staff level. The shorter cycle also enhances our ability to replan if a flight is delayed for any reason.

KSC has made similar progress in reducing the work days and shifts required to prepare the Orbiter and its payload for flight. As additional facilities come on-line, that will help assure reduced turnaround time.

Because there has been so much attention focused on turnaround time and its relation to flight rate, I want to point out that launch window constraints imposed by the payload and by STS operations considerations limit the actual flight rate to some fraction of that nominally available as a function of turnaround time. Launch window constraints derive from such considerations as the lighting conditions a communication satellite desires for its deployment; the lighting and weather conditions needed for STS abort landing sites; the orbital ephemeris conditions which define the minimum energy trajectory to a particular planet and the phasing relationships required for rendezvous with satellites to be serviced or recovered. To achieve a given flight rate and a high confidence in meeting schedule commitments when all these constraints are imposed requires nominal flow times and resources that would provide a much higher flight rate if there were no constraints.

During this period, I expect that we will begin to see significant numbers of commercial venture prototypes comparable to the Continuous Flow Eletrophoresis System (CFES) and the Monodisperse Latex Reactor (MLR) that we are now flying. I believe this will occur because the frequency of flight will make experimental process and product development more effective and economical and because the prospect of Space Station availability in the early 1990's will assure lower cost production quantity opportunities for successful developments.

I also expect that in the late 1980's and early 1990's we will use the STS to test and qualify technologies and systems that we will use in the Space Station.

- STS - Space Station Operations is the fifth and final phase. The STS and Space Station are complementary systems as was illustrated in our original studies in the early 1970's and as has been reaffirmed by the mission analysis studies conducted by the Space Station Task Force last year. The Space Station offers extended time on orbit and power, volume and crew time that could not be practical in a transportation system element such as the Orbiter. But in addition to these unique attributes, the Station enhances the effectiveness of the STS itself because as a depot it provides a place to store things on orbit; this permits an improved load factor; and since the Station is accessible every day, it allows the overall system to move many launch window constraints to the Station, which enhances the Shuttle Earth-to-orbit flight rate capability.

In the evolution of the STS and in the development of the Space Station, we need to keep in mind that there is only one set of customers for both the STS and the Station, and they will get to the Station aboard the Shuttle. We need to assure the customers that there shall be standard design practices, e.g. safety requirements and standard interface provisions. If we do not achieve such standards, it will create cost and schedule barriers that will inhibit the growth of space-based activities.

It seems likely that there can also be some hardware commonality to the mutual benefit of both programs.

In the early 1990's when the Space Station will buy its subsystems and components, many of the counterpart STS components will no longer be available because the solid state devices upon which they were designed will no longer be produced. For such items, a common procurement may be both practical and cost-effective as a way of upgrading the STS subsystems and providing a common logistics infrastructure for the Space Station and the STS in the mid-1990's.

These five phases each have a unique focus for emphasis. What I would like to address now are the management challenges I think are common to all of them.

The basic system design is proven, and we must assure that future changes are limited to the upgrades necessary to facilitate turnaround and lowering the cost per flight. Process control is now the key to our operational success. With the design fixed, we can in some areas relax operational procedures and checks; but in others, we must remain as vigilant as we were before STS-1. It will take considered judgment and an experimental approach to determine what procedural changes we can make without compromising quality, schedule assurance or safety.

There are some capital investments in ground facilities that can help us as we go forward. In recent years, the computer science efforts throughout the country have made significant progress in a form of artificial intelligence called expert systems. Our test and flight experience has developed expert knowledge about the Shuttle subsystems. By formulating the expert knowledge available in our people in the form of computer-manipulated data bases, we can enhance productivity and reduce the numbers of operational staff while maintaining a high level of quality assurance. These techniques are applicable to both the Mission Control Center and the launch processing system. I might add that implementing them for the STS will facilitate the application of this technology to the Station.

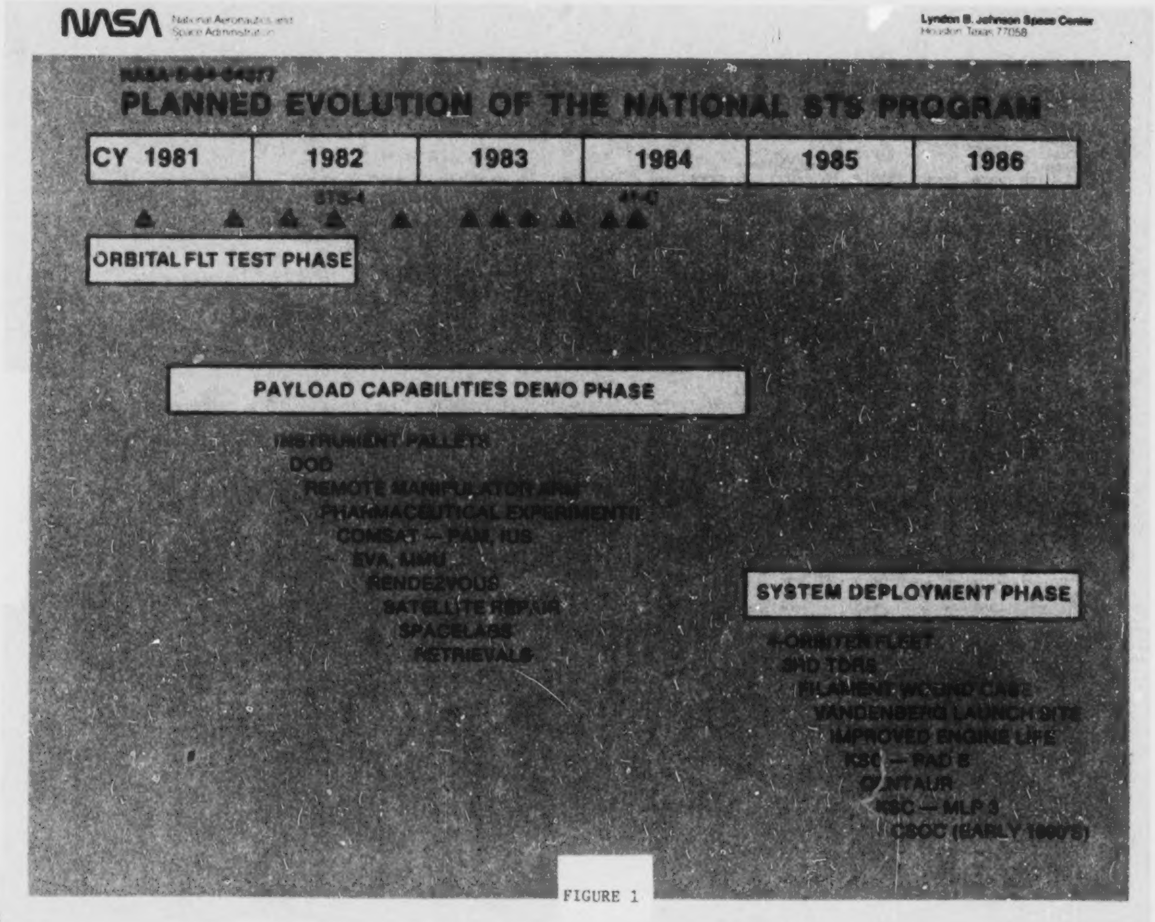
The common thread in all phases of the STS program is to manage risk. We cannot be so cautious that cost and schedule assurance are jeopardized nor can we afford to be casual when dealing with such a complex high energy system.

Let me conclude my remarks by summarizing our current efforts to streamline the STS organization and management structure. At JSC we have three major activities in progress, and I would like to briefly describe each.

We plan to consolidate a number of the contracts that currently support our Operations Directorates. The contractor observation period is in progress, and we have four companies participating. Our plans call for the competition to occur in early 1985 and the winner to be in place early in 1986. It is our plan to restructure our civil service organization prior to the time the new contract form is implemented. We believe the net effect of this action will be to reduce the civil service staff requirement for operations support and provide a functional structure for the contractor in which he can achieve economies in redeploying staff, while maintaining a capability to surge when circumstances warrant.

A similar consolidation is planned for the Flight Equipment Processing contract. This contract will provide for the maintenance, flight preparation and inventory control of the many items of crew and Orbiter equipment which fly and are a function of mission objectives, and the size of the crew. We anticipate economies in this consolidation by bringing the activity into a single facility and the elimination of redundant functions among the several contractors now processing various items. There will also be reduced civil service in these areas.

Finally, we are examining the structure of the National Space Transportation System (NSTS) and Space Shuttle Project Offices. In recent years, these organizations have grown as they completed the development, qualification and acquisition of the STS while the flight rate has grown from two a year to ten a year. With the delivery of OV-104 in sight, we plan to examine the relative roles of these two offices, focusing on consolidation and streamlining of functions. In the process of this consolidation, we will also consider transferring a number of functions to KSC. This will be a phased process, perhaps beginning as early as this year for some functions, but others not considered until the appropriate significant event occurs; for example, first flight of the Centaur stage. The design and development experience released by these actions will be made available to the Space Station.



NASA National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

NASA-S-84-04377

PLANNED EVOLUTION OF THE NATIONAL STS PROGRAM

CY 1981	1982	1983	1984	1985	1986

ORBITAL FLT TEST PHASE

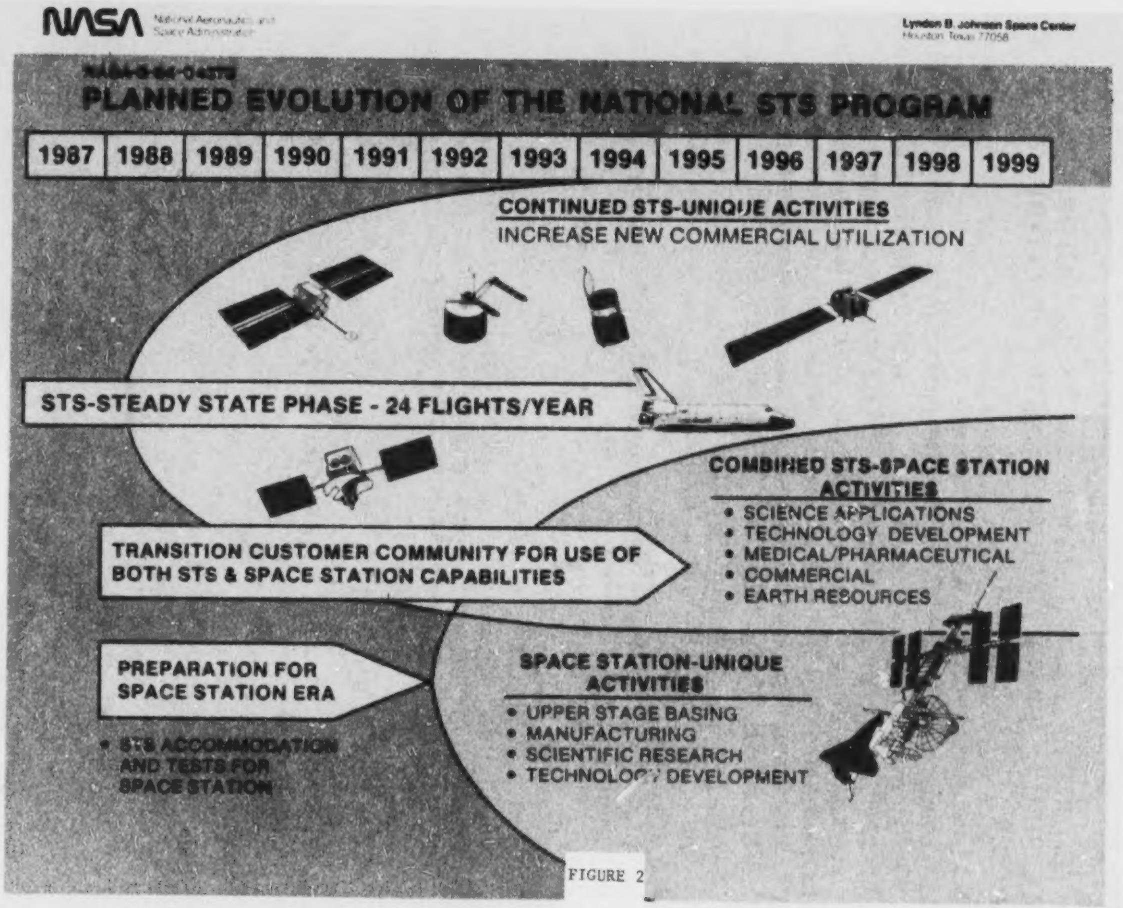
PAYLOAD CAPABILITIES DEMO PHASE

INSTRUMENT PALLETS
DOD
REMOTE MANIPULATOR ARM
PHARMACEUTICAL EXPERIMENTS
COMSAT — PAM, IUS
EVA, MMU
RENDEZVOUS
SATELLITE REPAIR
SPACELABS
RETRIEVALS

SYSTEM DEPLOYMENT PHASE

4-ORBITER FLEET
3RD TDRS
FILAMENT WOUND CASE
VANDENBERG LAUNCH SITE
IMPROVED ENGINE LIFE
KSC — PAD B
CENTAUR
KSC — MLP 3
CSOC (EARLY 1980'S)

FIGURE 1



NASA National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston Texas 77058

NASA-S-84-04379

PLANNED EVOLUTION OF THE NATIONAL STS PROGRAM

1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999

CONTINUED STS-UNIQUE ACTIVITIES
INCREASE NEW COMMERCIAL UTILIZATION

STS-STEADY STATE PHASE - 24 FLIGHTS/YEAR

TRANSITION CUSTOMER COMMUNITY FOR USE OF BOTH STS & SPACE STATION CAPABILITIES

COMBINED STS-SPACE STATION ACTIVITIES

- SCIENCE APPLICATIONS
- TECHNOLOGY DEVELOPMENT
- MEDICAL/PHARMACEUTICAL
- COMMERCIAL
- EARTH RESOURCES

PREPARATION FOR SPACE STATION ERA

- STS ACCOMMODATION AND TESTS FOR SPACE STATION

SPACE STATION-UNIQUE ACTIVITIES

- UPPER STAGE BASING
- MANUFACTURING
- SCIENTIFIC RESEARCH
- TECHNOLOGY DEVELOPMENT

FIGURE 2

Mr. VOLKMER. Thank you very much.

Dr. Lucas, you may proceed.

STATEMENT OF DR. WILLIAM R. LUCAS, DIRECTOR, GEORGE C. MARSHALL SPACE FLIGHT CENTER, ACCOMPANIED BY ROBERT E. LINDSTROM

Dr. LUCAS. Thank you, Mr. Chairman.

Mr. Chairman, I do appreciate the opportunity to appear before your subcommittee today to discuss the support of the Space Shuttle operations by the Marshall Space Flight Center projects. I have prepared a statement which I wish to submit for the record and will summarize that statement orally, with your permission.

Mr. VOLKMER. The record will show the statement in full.

Dr. LUCAS. Before beginning, I would like to recognize that I have with me Mr. Bob Lindstrom who is the Manager of the shuttle projects office at the space flight center. He is prepared to assist in any way needed.

As this subcommittee knows, the Marshall Space Flight Center has the management responsibility for the development and production of the ascent propulsion system of the shuttle, the solid rocket boosters, the external tank, and the space shuttle main engine. In addition, the scope of Marshall's support to operational missions includes the delivery of flight hardware and spares to the launch processing organizations in Florida and California, and the maintenance and refurbishment of the solid rocket boosters and space shuttle main engines.

The results of our early operational period affirm that the propulsion elements meet the performance specifications and that the hardware, with the exception of spares for the space shuttle main engine turbomachinery, was readily available. However, this operational experience also demonstrated that additional engineering and development are needed to further reduce the amount of maintenance and the refurbishment of the hardware. Additionally, it is evident that achievement of cost goals and launch turnaround goals require a sustaining engineering effort for the Marshall Center and its contractors. As is normal, a transition from development to operations with higher production rates generates new problems in product quality. Consequently, two formal quality readiness reviews have been conducted with our prime contractors, their major subcontractors, and our delegated inspection agencies. These reviews have involved key Government as well as contractor senior management. The results of these reviews provided additional confidence that the systems were in place to produce high quality products at the required rate. We plan similar reviews each two years to reaffirm the production of quality hardware and to insure continued emphasis on productivity improvements.

The Marshall Center and its industrial teams have accepted challenging cost goals for the hardware to be delivered in 1989, goals that will require a very substantial reduction in unit cost. Several initiatives have been in place for some time to reach these goals, and we have been very successful. However, we recognize that continued emphasis will be required for us to meet these goals. Excellent progress has also been made in preparing to provide full performance and cost effective hardware to support a 24 per year flight rate in 1989. To a large extent, this posture is due to the emphasis that was given to the operational needs during the design and development period. Our remaining effort is the improvement of mission life, the reduction of required hardware maintenance, meeting our unit cost goals, and maintaining product quality.

I will now discuss the key operational requirements of mission performance, hardware availability, and cost improvement separately for each of the projects for which we are responsible.

The prime contractor for the external tank is the Martin Marietta Corp., at the Michoud Assembly Facility in New Orleans, but the subcomponents and subsystems and components used in the assembly of these tanks are produced by several hundred subcontractors and suppliers located throughout the Nation, most of them under fixed price contracts. It is estimated that about 45 percent of the cost of the tank is on subcontracts. Beginning with unit 61, a fixed price incentive contract with Martin Marietta will replace the cost incentive fee contract now in effect.

The external tank's initial specification weight was 75,000 pounds, and a goal was established to reduce that weight by 6,000 pounds to provide increased payload capability. We were able to reduce the weight by more than 8,000 pounds and to do this on the set schedule and within the estimated cost. External tanks have been delivered on or ahead of schedule and fully support the shuttle manifest. The tooling and facility activation efforts at Michoud are proceeding as planned. In a study requested by the Congress, the National Research Council study group affirmed that the tooling and facilities will meet the requirements for producing 24 tanks per year. So far as I know, there are no open issues on support of mission operations by the external tank.

The unit cost of the external tank, in fiscal year 1982 dollars, was reduced by 43 percent from Unit 8 to Unit 15, delivered in fiscal year 1984, toward a cost reduction goal of 70 percent by unit 110, to be delivered in fiscal year 1990.

Now, these cost improvements are being achieved through production learning, through joint development efforts to improve producibility, and the procurement of the tank assembly under an incentive contract. To date, in the joint producibility improvement efforts, more than 300 candidate cost improvement actions have been assessed. The skills and facilities of both Government and contractor are dedicated to the pursuit of a quality product at a lower cost, and the efforts have been extremely successful.

This joint producibility program started in 1978, had a cost reduction goal of $66 million for the first 54 production tanks. That goal will be exceeded by a substantial amount. Cumulative savings for the 230 units in the mission model is estimated to exceed $350 million for which we invested $35 million. These producibility efforts will be continued to achieve the project cost goals.

Incentive contracting has motivated the prime contractor to improve production efficiency and streamline management operations without compromising the high quality hardware required to assure reliable missions. While incentive contracting provides the opportunity for additional earnings for the contractor, it also imposes substantial penalties for late delivery or hardware that malfunctions during a mission, thus, I believe, keeping the proper emphasis on the quality of the hardware.

Now turning to the solid rocket booster, there are two prime contractors for the solid rocket boosters, the Morton Thiokol Co. for the solid rocket motors and United Space Boosters, Inc., for the booster assembly and for the delivery of the forward and aft assemblies.

The operational performance of the solid rocket boosters has been excellent and has met or exceeded the system performance specifications. Since the initial development flights, the shuttle payload capability has been increased by 4,400 pounds through incorporation of improvements to the boosters. These improvements include an increase in the nozzle expansion ratio which accounts for about 3,800 pounds, and a reduction of motor case weight accounting for another 600 pounds. As a further improvement, the filament wound case will be used in lieu of steel cases in the boosters on certain high performance missions originating principally from the Vandenberg Air Force Base.

The first development test firing of the filament wound case, designated DM-6, is on schedule for November 1984, and the initial set of filament wound case flight motors will be delivered to Vandenberg Air Force Base in the spring of 1985 to support an October launch. The use of these cases adds another 4,600 pounds to the shuttle payload capability. The performance gain from the use of the increased nozzle expansion ratio and the filament wound case is 8,400 pounds of payload. The delivery of complete solid rocket boosters has remained on or ahead of schedule. The current production rate is 12 sets per year, and the tooling and facilities are in place or planned to be completed in fiscal year 1987 to support a flight rate of 24 per year.

Morton Thiokol has established the necessary facilities and tooling for solid rocket motor production at Brigham City, and recently has activated a motor case and nozzle refurbishment facility at Clearfield, UT. This facility, which centralizes all case recycle operations in one building, reduces transportation and handling cost and relieves a congested process flow in the inert case processing complex at Brigham City. Also, during this past year, authorization was granted to Morton Thiokol to construct enclosures for the motor casting operations conducted in two rows of pits at Brigham City formerly exposed to the weather.

This facility modification will permit solid rocket motor casting operations to proceed uninterrupted by inclement weather. Construction of the enclosure for the north casting pits has been completed already, and construction of the enclosure for the south row of pits will be completed late this year. The completion of these covers will ensure the capability of Morton Thiokol to process the motors required for 24 flights per year. Thiokol has invested more than $44 million of company funds in production facilities, of which $37 million were for dedicated work for dedicated shuttle facilities and $7 million were for general purpose facilities also used for shuttle. The existing interim booster assembly and refurbishment facilities and tooling will support a rate of 16 sets per year. The current competition for a booster assembly contract to provide for follow on production requires that the selected contractor must build a dedicated facility designed for efficient 24-per-year production. This facility will be operational in fiscal year 1986.

The unit cost of the solid rocket booster, in fiscal year 1982 dollars, was reduced by 31 percent from unit 6 to unit 15, delivered in fiscal year 1984, toward a cost reduction goal of 59 percent for unit 110, planned for delivery in fiscal year 1990. The methods for accomplishment of cost improvements on the solid rocket booster are similar to those for the external tank, increased learning, productivity improvements, and incentive contracting.

The Marshall Center and the prime contractors have aggressively examined over 150 candidates for cost reduction in areas such as design improvements, process and turnaround enhancements, and some reductions of requirements. We are achieving the planned rate of improvement for maintenance and refurbishment on all subsystems other than the aft skirt structure and the thrust vector control system. The water entry loads on these components have been higher than originally predicted, but significant improvements are being made to further decrease such damage. Cost plus incentive fee contracts were signed in April 1983 with Thiokol for solid rocket motors, and in September 1983, with USBI for the booster assembly.

The prime contractor for the space shuttle main engine is the Rocketdyne Division of Rockwell International, and the engines are produced under a cost plus award fee contract at this time. The flight engines have achieved the specification value for specific impulse and dry weight, and have been operating at 100-percent and 104-percent thrust levels, but not at the full thrust level of 109 percent or so-called rated power level. The initial specification for the engine was for a normal operating thrust of 470,000 pounds which is referred to as 100-percent thrust or rated power level. The requirement for a 109-percent thrust level was not originally a normal operating requirement, but in December 1973, because of the need to meet maximum payload capability, a portion of engine life was designated for normal operation at 109-percent thrust level. Today, the engine is qualified to operate at that level, 109-percent, but since our near-term missions do not require this high thrust level, NASA has chosen to operate the engines at 104 or below to extend the service life of the engine components. We will continue to use this thrust level. Of course, in an emergency, we could go higher, but we will continue to use the 104-percent until improvements necessary to extend the life of the engine components are completed and certified for flight.

The engine improvement activity has been divided into two steps referred to as phase II and phase III. The major purpose of phase II is to extend the service life capability of the high pressure pumps to accomplish a 10 mission or 5,000 second certification test series at the full power level, 109-percent, without replacement of the turbo machinery. Engine testing is on schedule and certification is expected to be completed in 1985 for use in early 1986. Phase III is to achieve an engine with increased operating margins that will extend its life, for example, operating the rotating machinery at lower temperatures and reduced speeds. Designs are being finalized and hardware is in fabrication for development testing to begin in early 1985.

The engine has met or is on schedule to meet the inspection and maintenance goals of 35 days for orbiter turnaround in launch processing. However, unplanned replacement of components, primarily turbomachninery, has increased the need for replacement hardware and the amount of manpower required to support the turnaround schedule. Although there is still a shortage of spare engine hardware, the space shuttle main engine program is supporting the mission schedule by allocating engines and major engine components as necessary to the priority requirements. The phase II and phase III improvement program, together with productivity measurements being implemented, will resolve the availability issues and the space shuttle main engine can support a 24 per year flight rate in fiscal year 1989.

As a part of the productivity improvement efforts and to resolve manufacturing problems in producing quality hardware, Marshall and Rocketdyne have agreed to a joint $35 million program to improve the accuracy of critical machine tools. In addition to that amount, Rocketdyne is making a $55 million investment to provide efficient, dedicated facilities and tooling for turbopump manufacturing and engine overhaul. We expect to be operating in these new facilities in fiscal year 1986.

The predominant factors influencing space shuttle main engine cost per operational mission are the costs for engine maintenance and component replacement and the certification of flight readiness for each mission. The improvement program should reduce cost of operations by increasing component life operating margins, thus reducing component replacement and engine maintenance, and allowing a more routine approach to the flight readiness certification effort. It has not been practical yet to convert the engine contracts from cost plus award fee, but we are working toward incentive contracts for all deliverable engine hardware.

A number of management actions have been taken or are planned to focus Marshall and contractor attention to the support of mission operations. Among these were the establishment of separate project organizations at Marshall and Rocketdyne to support mission operations. For example, the flight engine project and the development engine project have been established, the development engine project being responsible for the phase II and phase III improvements. In each of the project offices supporting mission operations, the flight engine, the external tank, and solid rocket booster, we have shifted staffing to production management fields as the development matured. A single group has been designated at Marshall to manage all of our support for the Vandenberg operations.

Our logistics plans are based primarily on providing spares for the continuing external tank and solid rocket booster production assets, thus reducing to a minimum the procurement and cost for dedicated spares stored at KSC and VAFB. The space shuttle main engine will have an ongoing production of components and engine overhaul that provides a source for spares. Since the engine line replaceable units are replaced between missions, logistics spares are being provisioned at the launch sites.

In summary, the Marshall projects are supporting and can support shuttle mission operations to the current manifest. These projects can support an increased flight rate in fiscal year 1987, and the tools and facilities are being put in place to support a 24-per-year flight rate in fiscal year 1989. The attention, I believe, that we gave to operational needs during the development program has paid good dividends, and, therefore major organizational restructuring has not been required. The Marshall Center team and its industry team members are committed to a responsive, cost effective, and successful operational shuttle program.

Mr. Chairman, that concludes my summary, and I will be glad to respond to questions at the appropriate time.

[The prepared statement of Dr. Lucas follows:]

STATEMENT

of

DR. WILLIAM R. LUCAS
DIRECTOR, MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to appear today to discuss the evolution of the Space Shuttle from the research and development phase to a versatile, dependable system that will bring substantial benefits to the Nation as it provides transportation into space for a wide variety of commercial customers and government agencies. The Shuttle Program is in the early operational phase that leads to a capability for a mission rate of 24 flights per year in the late 1980's. The Shuttle Projects managed by the Marshall Space Flight Center (MSFC) support mission operations today and can support the full mission rate planned for the late 1980's. There are no significant technical or management issues precluding this achievement.

The Marshall Space Flight Center has management responsibility for the development and production of the Solid Rocket Booster, the External Tank, and the Space Shuttle Main Engine. These elements constitute the Shuttle ascent propulsion system and MSFC, along with the Johnson Space Center, is responsible for the analysis and verification of this system. MSFC provides launch operations support by determining launch processing requirements, certifying readiness and assessing flight performance of the propulsion system. In addition to this engineering responsibility, the scope of the Center's support to operational missions includes the delivery of flight hardware and spares to the launch processing organizations, Kennedy Space Center (KSC) in Florida and the U.S. Air Force at Vandenberg AFB, California, and the maintenance and refurbishment of the Solid Rocket Boosters and Space Shuttle Main Engines. The delivered hardware must meet performance specifications, be readily available, be of high quality, require minimum effort by the launch processing agency, and be delivered at a reasonable price. The results of the early operational period, extending over seven missions, affirmed that the propulsion elements meet the performance specifications; that the hardware, with the exception of spares for Space Shuttle Main Engine turbomachinery, was readily available; and that the hardware performed successfully during each mission. The operational experience acquired during this period demonstrated that additional engineering and development are needed to further reduce the maintenance and refurbishment of the hardware. Additionally, continued achievement of cost and launch turnaround goals requires a substantial engineering effort by MSFC and its contractors.

Typical of most systems, a transition from development to operations with an attendent higher production rate generates new problems in product quality. New tools, vendors, people and, in many cases, new processes to produce the additional hardware are required. To emphasize the importance of quality hardware and to ensure its production, formal quality readiness reviews have been conducted to assess our projects. A Safety and Quality Assurance Readiness Review was conducted in 1978 and 1979, prior to the launch of the first manned orbital flight. A Production Quality Readiness Review was conducted in 1983 and 1984, to certify the capability to produce quality hardware for the production phase. These were comprehensive reviews with our prime contractors, major subcontractors and delegated inspection agencies, involving key government and contractor senior management. Actions were identified and issues were resolved during these reviews, with follow-up reviews to assure proper closeout. As part of this program, each prime contractor held motivational meetings and reviews with its key subcontractors and suppliers. The results of these readiness reviews provided additional confidence that systems were in place to produce high quality products at the required rate. We plan a similar review every two years to reaffirm the production of high quality hardware and to ensure continued emphasis on productivity improvements.

The effectiveness of the Shuttle, with resultant benefits to the Nation, can be realized only if we are able to accurately project and control the cost, and only if that cost is reasonable. MSFC and its industrial team have accepted challenging cost goals for the hardware to be delivered in 1989 -- goals requiring substantial reduction in unit cost. Factors which contribute to this cost reduction include: learning from repetition and an increased production rate, joint NASA laboratory-industry productivity activities resulting in simplified processes and tools, activities to stimulate worker motivation and productivity, engineering developments to increase mission life, and increased company motivation through potential for higher profits by producing quality elements at a lower cost. These programs have been in place to a degree for several years and have been successful in reducing hardware costs. The continuation of all of these programs is necessary to achieve the established cost goals.

It is my judgment, that the MSFC Projects are well on the road to delivering full performance and cost effective hardware of adequate quality as well as supporting a 24 per year flight rate in FY89. To a large extent, I credit this excellent posture to the emphasis given to the operational needs during the design and development period. The remaining effort to be accomplished is improvement of mission life, reduction of maintenance, and meeting the product quality and unit cost goals. This effort is properly planned and budgeted.

In continuing my testimony, I will address separately the key operational requirements of mission performance, hardware availability, and cost improvement for the External Tank, the Solid Rocket Booster, and the Space Shuttle Main Engine. The operations budget for these elements totals 1.007 billion dollars in FY85, and pays for the required prime contractors, subcontractors and suppliers across the Nation. The estimated FY85 expenditures of the MSFC projects by state are shown in Figure 1.

EXTERNAL TANK

The prime contractor for the External Tank is the Martin Marietta Corporation (MMC), which produces the tanks at the MSFC Michoud Assembly Facility in New Orleans, Louisiana. Subsystems and components used in assembly of the tanks are produced by several hundred subcontractors and suppliers, including: Avco in Nashville, Tennessee; Aircraft Hydro-forming in Los Angeles, California; and Reynolds Aluminum in McCook, Illinois. Most of these subsystems, components, and materials are procured under fixed price contracts. External Tanks through unit 60 are being produced under a cost plus incentive fee contract with Martin Marietta, and procurement on tanks 61-120 is being initiated under a fixed price incentive contract.

Performance

The External Tank primary specification affecting payload capability is weight. The specification weight at the onset of the program was 75,000 pounds, and the first six tanks achieved the specification requirements. Subsequently, the need for increased payload capability created a requirement to reduce the weight by 6,000 pounds. I am pleased to report that this weight reduction program was completed on schedule, within estimated cost, and that the actual weight reduced, or payload gained, was more than 8,000 pounds. Tanks currently being delivered are below specification weight and meet all operational peformance requirements.

Availability

External Tanks have been delivered on or ahead of schedule and fully support the Shuttle manifest. To date, 20 tanks have been completed and 17 have been delivered to the launch site. One additional tank will be completed during the remainder of FY84, 12 tanks in FY85, and 14 tanks per year in FY86 and FY87. Delivery rates in FY87 can be increased if a decision to do so is made by mid-FY85. The tooling and facility activation efforts at Michoud Assembly Facility are proceeding as planned to provide the capability for a 24 tanks per year delivery rate in FY87. Concurrently, subcontractor/supplier capability is being increased to supply the subsystems, components, and materials. The National Research Council, in a study requested by the Congress, affirmed that the tooling and facilities will meet the requirements for producing 24 tanks per year.

There are no open issues related to the availability of External Tanks to support mission operations.

Cost Improvement

The cost per unit of the External Tank, expressed in constant year FY82 dollars, was reduced by 43% from unit 8 to unit 15, delivered in FY84, toward a cost reduction goal of 70% by unit 110, to be delivered in FY90. Cost improvements are being achieved through learning, joint MSFC/Martin Marietta development efforts that are improving the producibility of the tank, and incentive procurement of the tank assembly which includes fixed price competition with subcontractors.

The Center is conducting producibility improvement efforts jointly with the contractor. To date, more than 300 candidate cost improvement actions have been assessed. Typical improvements are results of the work accomplished by MSFC and Martin Marietta personnel working side-by-side to develop a lower-cost foam insulation that reduces the tank weight by 145 pounds and processing costs by $120,000 per tank. Another example is the joint development of a welding process that results in significantly fewer process defects, and, along with this improved quality, provides a savings of $125,000 per unit. The skills and facilities of both government and contractor organizations are dedicated to the pursuit of a better product at a lower cost, and the efforts have been extremely successful. Other cost improvements implemented involve a reduction in requirements and minor design changes to allow more efficient manufacturing. This joint producibility program was started in 1978 and had as a goal a 66 million dollar reduction in cost of the first 54 production tanks. I am pleased to report that we project that the goal will be exceeded and in the procurement of these 54 units we expect to achieve a cost reduction of 76 million dollars. Projecting these savings for the 230 units in the mission model indicates the cumulative savings will exceed 350 million dollars. This savings results from an investment of 35 million dollars. I am extremely pleased with this favorable return on investment ratio. The continuing investment in such producibility efforts is essential if we are to achieve the cost goals for the External Tank, as well as for the Solid Rocket Booster and Space Shuttle Main Engine.

Incentive contracting has motivated the contractor to improve production efficiency and streamline management operations without compromising the high quality hardware required to assure reliable missions. The cost-incentive contracts provide the contractor a larger profit if the cost is below target, and reduces his profit if the cost is above target. The contracts also call for a penalty for mission failure and a penalty for late delivery. Thus the incentive contracts emphasize reduced cost, delivery of a quality product, and the availability of the product. The contractor has recompeted procurements representing 55% of the subcontract cost and plans further recompetiton after award of a fixed price incentive contract for units 61 - 120. Currently, 96% of the subcontract procurement cost is fixed price. Recognizing the stability of the program and maturity of the design and manufacturing process, Martin Marietta is implementing organizational changes and other management actions that will provide a reduction of more than 40 million dollars in current contract cost, and an estimated savings for units 61-120 greater than 100 million dollars.

In addition to the cost reduction being achieved on the delivered unit, other efforts have been successful in reducing the launch processing accomplished at KSC. Receiving inspections and tests have been eliminated, insulation closeout has been simplified, and the interface with the Solid Rocket Booster has been redesigned for faster stacking and assembly. The result is a substantial savings in time and manpower in launch processing.

SOLID ROCKET BOOSTER

There are two prime contractors for the Solid Rocket Boosters: Morton Thiokol, Inc. for the Solid Rocket Motor and United Space Boosters, Inc. for delivery of the forward and aft assemblies. The initial design and development of the forward and aft assemblies were accomplished in-house by MSFC. The delivery and the sustaining engineering for these assemblies have been turned over to United Space Boosters, Inc., but MSFC retains the engineering responsibility for the complete booster system. Morton Thiokol conducts the motor loading operations at Brigham City, Utah, and has separate case refurbishment facilities at Clearfield, Utah. Kerr McGee and Pacific Engineering are dual source suppliers of the ammonium perchlorate, a major ingredient of the propellant. The capacity of each has been expanded such that the combined capacity is sufficient to support a 24 per year flight rate as well as known material requirements of other customers. The polymer, which is the other major propellant ingredient, is supplied by American Synthetic Rubber of Louisville, Kentucky. Steel case segments are produced by Rohr Industries, Inc. at Chula Vista, California, and Filament Wound Case segments are produced by Hercules, Inc. at Clearfield, Utah. Steel case segment production capacity is limited; however, with the low rate of attrition experienced, a 24 per year flight rate can be supported. With the reduced manifest, we are currently procuring cases below the maximum rate, and plan to maintain this production rate so as not to encounter shutdown and resultant startup problems. .

United Space Boosters, Inc. has operations in Huntsville, Alabama and at the Kennedy Space Center in Florida. The current contract provides for delivery through flight set 37. Follow on deliveries will be procured from a contractor selected through an ongoing competition. Selection for the follow-on contract will occur in the next few months.

Performance

The contribution of the Solid Rocket Boosters to the payload capability of the Shuttle is measured in terms of the delivered thrust, total impulse, and the net weight. The operational performance of the boosters has been excellent and has met or exceeded the system performance specifications. Since the initial development flights, the Shuttle payload capability has been increased by 4,400 pounds through incorporation of improvements to the boosters. These improvements include an increase in the nozzle expansion ratio (payload increase of 3,800 pounds), and a reduction in motor case weight (payload increase of 600 pounds). As a further improvement, the Filament Wound Case will be used in the boosters on certain high performance missions, originating principally from Vandenberg Air Force Base, California. The first development test firing of the Filament Wound Case, designated as DM-6, is on schedule for November 1984, and the initial set of Filament Wound Case flight motors will be delivered to Vandenberg Air Force Base in the spring of 1985 to support an October launch. The use of these cases adds another 4,600 pounds to the Shuttle payload capability. Figure 2 shows a Filament Wound Case in manufacturing. The performance gain from use of the increased nozzle expansion ratio and the filament wound case is 8,400 pounds of payload. No further performance improvements are planned.

Availability

The delivery of complete Solid Rocket Boosters has remained on or ahead of schedule. The current production rate is 12 sets per year, and the tooling and facilities are in place or planned to be completed in FY87 to support a flight rate of 24 per year.

Morton Thiokol has established the necessary facilities and tooling for Solid Rocket Motor production at its Brigham City, Utah facility, and recently has activated a motor case and nozzle refurbishment facility at Clearfield, Utah. This facility reduces transportation and handling cost and relieves a congested process flow in the inert case processing complex at Brigham City, by centralizing all case recycle operations in one building. Also, during the past year, authorization was granted to Morton Thiokol to construct enclosures for the motor casting operations conducted at two rows of pits at the Brigham City facility. This facility modification will permit Solid Rocket Motor casting operations to proceed without interruption by inclement weather. Construction of the enclosure for the north casting pits has been completed as shown in Figure 3. The enclosure for the south row of pits will be completed in late 1984. The completion of these covers will ensure the capability of Morton Thiokol to process the motors required for 24 flights per year. Morton Thiokol has invested more than 44 million dollars of company funds in production facilities, of which 37 million dollars were for dedicated Shuttle facilities and 7 million dollars for general purpose facilities also used for Shuttle.

Interim booster assembly and refurbishment facilities and tooling will support a rate of 16 sets per year. The current competition for a booster assembly contract to provide for follow on production requires that the selected contractor must build a dedicated facility designed for efficient 24 per year production. This facility will be operational in FY86.

There are no significant issues related to Solid Rocket Booster hardware availability.

Cost Improvement

The cost per unit of the Solid Rocket Booster, expressed in constant year FY82 dollars, was reduced by 31% from unit 6 to unit 15, delivered in FY84, toward a cost reduction goal of 59% for unit 110, planned for delivery in FY90. The methods for accomplishment of this goal are similar to those applied to the External Tank: increased learning, productivity improvement, and incentive contracting.

As in the case of the External Tank, MSFC and the contractors have aggressively examined over 150 candidates for cost reduction in the general categories of design improvements, process and turnaround enhancements and reduction of requirements. Examples of design improvements resulting from this program include: a redesign of the External Tank Attach Ring, Systems Tunnel, Forward Range Safety Crossover, and External Tank/Solid Rocket Booster Strut Cover. These changes will result in a cost reduction of $318,000 per flight. Emphasis has also been placed on producibility improvements for the areas of thermal protection system design and application and thermal protection system removal. A new thermal ablator is being developed in-house as well as an automated technique using robotics to remove the ablator after flight. In addition, maintenance and refurbishment efforts must be minimized to further enhance cost improvements. We are achieving the planned rate of improvement for maintenance and refurbishment on all subsystems other than the aft skirt structure and thrust vector control system. The water entry loads on these components have been higher than originally predicted, but significant improvements are being made to further decrease the damage from water impact. These include a reinforcement of the basic structure, a reduction of water intrusion into the components, the application of spray foam in certain places in the aft structure to attenuate water forces, and use of larger main parachutes to reduce the booster velocity at water impact. Parachute damage experienced in recent missions is being corrected primarily by smoothing the path the chute takes as it strips out of the booster frustum.

Cost plus incentive fee contracts were signed in April 1983 with Morton Thiokol for Solid Rocket Motors, and in September 1983 with United Space Boosters, Inc. for booster assembly. The current contracts with Morton Thiokol and United Space Boosters, Inc. require a production rate of 11 flight sets per year for FY85, 14 per year for FY86 and 15 per year for FY87. The capability remains to produce both the Solid Rocket Motor and the Solid Rocket Booster at a higher rate and thus support an increased mission rate in FY87.

SPACE SHUTTLE MAIN ENGINE

The prime contractor for the Space Shuttle Main Engine is the Rocketdyne Division of Rockwell International Corporation located at Canoga Park, California. Acceptance testing of the engine is performed by Rocketdyne using MSFC's facilities at the National Space Technology Laboratories located at Bay St. Louis, Mississippi. The majority of depot maintenance is performed at the Canoga Park Facility.

The Space Shuttle Main Engine is produced under a cost plus award fee contract, and currently Rocketdyne is under contract for 31 deliverable engines.

Performance

The Main Engine contribution to Shuttle payload capability is measured in terms of delivered specific impulse, delivered thrust, and dry weight of the engine. The flight engines have achieved the specification value for specific impulse and dry weight, and have been operating at the 100% (rated power level) and 104% thrust levels. The initial specification for the engine was for a normal operating thrust level of 470,000 pounds which is referred to as 100% thrust or rated power level. However, in the event of an emergency where one engine shuts down during flight, the remaining two engines were required to be able to increase the thrust level to 109% for the remainder of that flight. Therefore, the requirement for a 109% thrust level was not originally a normal operating requirement. In December 1973, because of the need to meet maximum payload capability, a portion of engine life was designated for normal operation at the 109% thrust level. Today, the engine is qualified to operate at the 109% thrust level. Since near-term missions do not require this high thrust level, NASA has chosen to operate the engine at 104% or below to extend the service life of the engine components. The restriction to this thrust level (except in an emergency) will continue until improvements necessary to extend the life of the engine components are completed and certified for flight. While the primary purpose of the improvement program is to reduce operational costs by increasing the life of turbomachinery, the improvement program also provides for increased operating margins and the growth potential for a higher thrust level.

The engine improvement activity has been divided into two evolutionary steps: Phases II and III. The approach to the first step (Phase II) is to extend the service life of the high pressure pumps by accomplishing the following: (1) increase the life of the high pressure oxidizer turbopump bearings, (2) reduce the high pressure fuel turbopump turbine operating temperature, and (3) increase the life of the turbine blades on both the high pressure oxidizer turbopump and the high pressure fuel turbopump. The goal of Phase II is to accomplish a 10 mission (5,000 seconds) certification test series at full power level (109%) without replacement of the turbomachinery. Engine testing is on schedule and, in conjunction with analytical efforts, these tests indicate that the Phase II goals will be achieved. Certification is expected to be completed in 1985 for the use of these improvements on the planetary missions in early 1986.

The second step (Phase III) in the improvement program is aimed primarily at providing an engine that will operate with increased margins (operating points substantially below the design points) and thus extend the life, and provide a capability for growth. This will be accomplished by: (1) reducing operating pressures and temperatures by enlarging the main combustion chamber throat, (2) reducing the magnitude of flow oscillations and pressure fluctuations by taking advantage of analytical tools and improved powerhead designs now available with the advent of super computers, and (3) strengthening critical elements (heat exchanger, liquid oxygen injector posts) to increase structural margins. While the strengthening of critical elements will cause a slight increase in the engine weight, the result will be an engine with significantly increased mission life thereby affording a reduction in operating cost. At the nominal mission thrust level of 104%, Phase III will: (1) reduce high pressure fuel turbopump temperature by 300° F, speed by 1,000 RPM, and pressure by 500 PSI, (2) reduce high pressure oxidizer turbopump speed by 500 RPM, and pressure by 130 PSI, and (3) reduce hot gas fluctuating pressures by 70%. Design modifications to achieve these improvements are being finalized and hardware is in fabrication. Development testing will start in early 1985 and certification testing completion is scheduled for 1989.

In regard to meeting the operational goals for launch processing time, the engine has met or is on a scheduled plan to meet the inspection and maintenance turnaround goals of 35 workdays for the Orbiter. However, unplanned replacement of components, primarily turbomachinery, has increased the need for replacement hardware and the manpower required to support the turnaround schedule. The improvements coming from Phase II and Phase III programs will reduce the unplanned replacements, and productivity measures will improve the availability of spares.

There are 23,000 inches of weld in a Space Shuttle Main Engine which is equivalent to about two-thirds of that in an External Tank. The welding involves high strength and high technology materials. Currently, there is a substantial amount of manual welding on the SSME, thus repeatability and quality of welds are highly dependent on the performance of the individual technician. A joint MSFC-Rocketdyne Productivity Improvement Program has been initiated to reduce cost and improve quality of Space Shuttle Main Engine welds through automation. Current automatic welding systems are limited to preprogrammed paths and parameter controls and can only be used for simple geometric shapes. The advancing aerospace technology requires the welding of complex shapes, thus the need for adaptive, closed-loop systems for real-time control of the weld process. Advanced components, sensors, and robotics technology will be used in the control system. This will benefit not only the Shuttle program but also the aerospace industry at large. Thus, an important element of this program is to demonstrate implementation of technology and disseminate information to potential users. We plan, at MSFC, a robotic welding demonstration center where systems developed will be accessible to industry and the general public.

Availability

Although there is still a shortage of spare engine hardware, the Space Shuttle Main Engine program is supporting the mission schedule by reallocating engines and major engine components as necessary to the priority requirements. While supporting flight missions, reallocation has delayed the full thrust main propulsion system test (now scheduled for September 1984) and caused delays in testing and certification of needed production improvements. The Phase II and Phase III improvements, together with productivity measures being implemented by MSFC and the prime contractor, Rocketdyne, will resolve the availability issues, and the Space Shuttle Main Engine can support a 24 per year flight rate in FY88.

As a part of the productivity improvement efforts and to resolve manufacturing problems in repeatably producing quality hardware, MSFC and Rocketdyne have agreed to a joint $35 million program to improve the accuracy of critical machine tools. A total of 65 machines are scheduled for refurbishment or replacement. Initial receipt of machine tools has begun and will be completed in FY85. In addition, Rocketdyne is making a $55 million investment to provide efficient, dedicated facilities and tooling for turbopump manufacturing and engine overhaul. All depot level maintenance for the turbomachinery and engine overhaul will be accomplished in these facilities. Operation in these new facilities is projected to begin in FY86.

Cost Improvement

The predominant factors influencing Space Shuttle Main Engine cost per operational mission are the costs for engine maintenance and component replacement and the certification of flight readiness for each mission. The Phase II and Phase III improvement programs are salient to a reduced cost of operations by increasing component life operating margin, thus reducing component replacement and engine maintenance, and allowing a more routine approach to the flight readiness certification effort.

We are planning the implementation of a contract incentivizing cost, quality and hardware delivery for all deliverable engine hardware (initial deliveries, spares, and overhaul) similar to the production contracts we have for the Solid Rocket Booster and External Tank. This will further motivate the contractor to deliver quality hardware on time and at a reasonable price.

MANAGEMENT

A number of management actions have been taken or are planned to focus MSFC and contractor attention to the support of mission operations. Among these were the establishment of separate project organizations at MSFC and at Rocketdyne to support mission operations (Flight Engine Project) and a separate organization (Development Engine Project) to implement the Phase II and Phase III product improvements. In each of the project offices supporting mission operations, Flight Engine, External Tank and Solid Rocket Booster, we have established production management offices or increased the staffing. In our Systems Management Office, a single group is managing the accomplishment of all MSFC support for Vandenberg AFB operations.

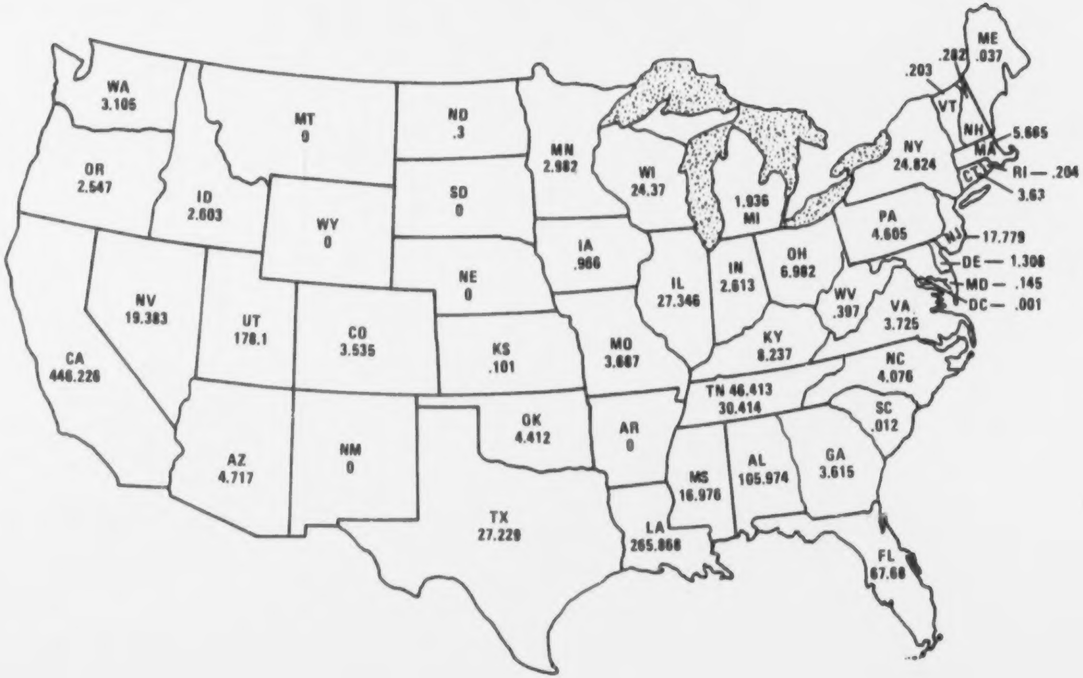
To control the cost of spares, our provisioning plans are based primarily on providing logistic spares from the ongoing External Tank and Solid Rocket Booster production assets, thus reducing to a minimum the procurement and cost for dedicated spares stored at KSC and Vandenberg Air Force Base. The Space Shuttle Main Engine will have an ongoing production of components for engine overhaul that provides the source for spares.

SUMMARY

In summary, the MSFC Projects are supporting and can in the future support Shuttle mission operations to the current manifest. Further, these Projects can support an increased flight rate in FY87. The tools and facilities are being put in place to support a 24 per year flight rate in FY89. The attention given to operational needs during the development program has paid dividends in enhancing a strong operational support posture and precludes the need for major management changes to provide further focus and attention. Remaining issues center on the reuse, refurbishment and mission life of selected Solid Rocket Booster and Space Shuttle Main Engine components, and efforts to resolve these issues have been implemented. MSFC and its industry team members are committed to a responsive, cost effective and successful operational Shuttle Program.

Mr. Chairman, this concludes my prepared testimony, and I will be glad to respond to any questions you may have.

PROJECTED COMMITMENTS IN FY85 BY STATE FOR MSFC ELEMENTS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SD 0
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IL 27.346
MS 16.976
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KY 8.237
TN 46.413 30.414
AL 105.974
GA 3.615
FL 67.68
SC .012
NC 4.076
VA 3.725
WV .397
PA 4.605
NY 24.824
.203
VT
.282
ME .037
NH
MA
5.665
CT
RI — .204
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NJ
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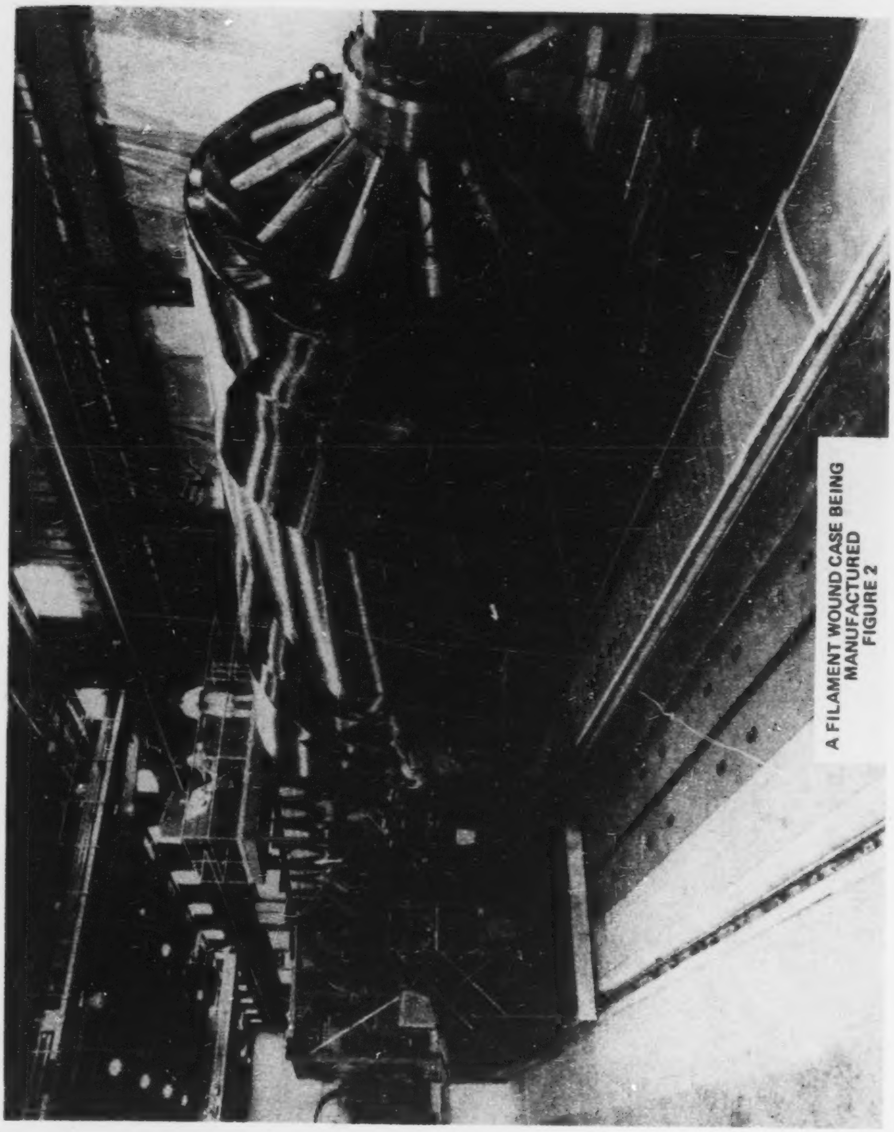
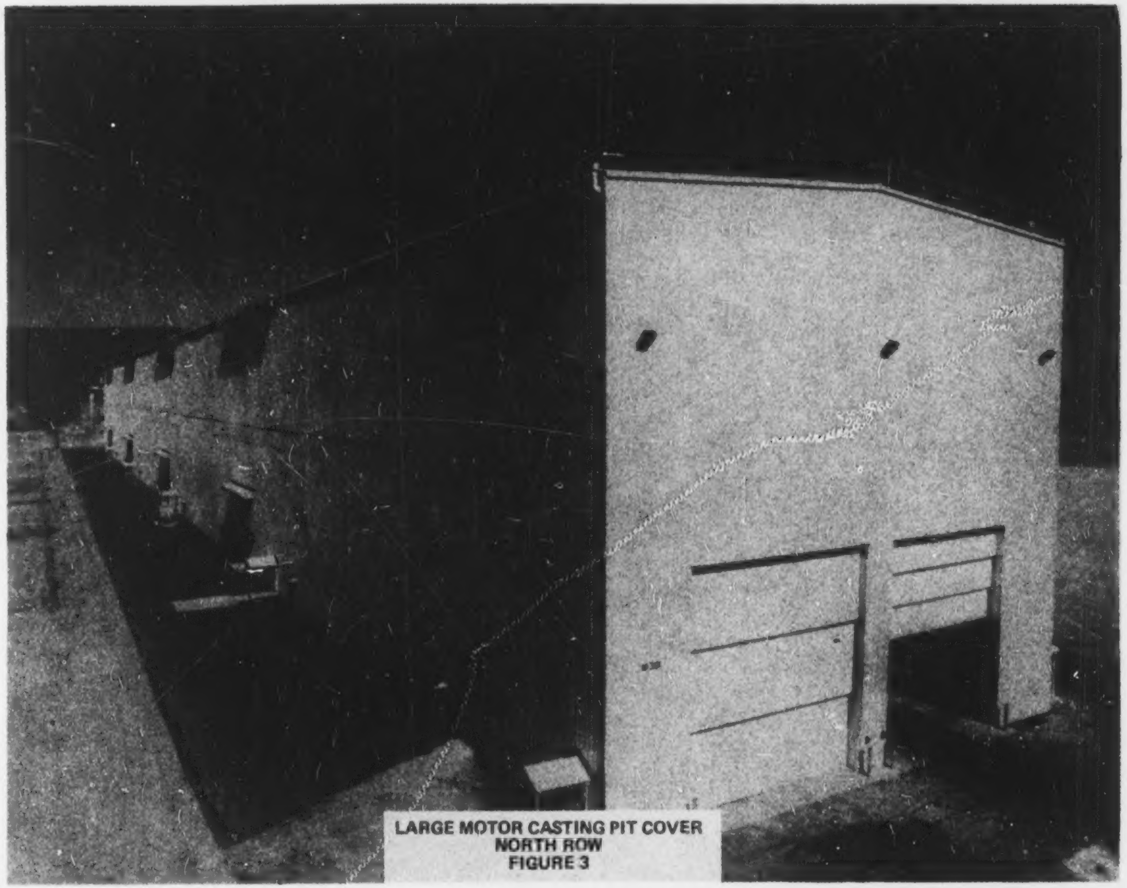
DE — 1.308
MD — .145
DC — .001

NOTE: ALL STATE DOLLARS ARE IN MILLIONS

FIGURE 1



A FILAMENT WOUND CASE BEING MANUFACTURED
FIGURE 2



LARGE MOTOR CASTING PIT COVER
NORTH ROW
FIGURE 3

Mr. **Volkmer**. Thank you very much, Dr. Lucas.

Mr. Smith.

Mr. **Griffin**. Mr. Chairman, if I could, before Mr. Smith starts, I overlooked telling you that, as you requested, Mr. Glynn Lunney is here who is the space shuttle program manager and can join us if you so desire.

Mr. **Volkmer**. All right. Thank you.

STATEMENT OF RICHARD G. SMITH, DIRECTOR, JOHN F. KENNEDY SPACE CENTER, ACCOMPANIED BY TOM UTSMAN

Mr. **Smith**. Mr. Chairman and members of the subcommittee, it is a pleasure to be here today to give you a little insight into what we at Kennedy are doing to reduce the costs and improve the operational effectiveness of the STS system. I have with me today Mr. Tom Utsman, Director of Shuttle Management Operations at the Center, who can assist with questions as appropriate.

I would like to submit my testimony for the record and summarize it briefly.

About 7 years ago, various people at the Kennedy Space Center started studying what would be the most operationally effective way, contract or otherwise, to operate once the shuttle was through its development phase and into its operational phase. That study and subsequent contract activities culminated in September of 1983 in the award to Lockheed Space Operations Co. of a shuttle processing contract. They are responsible for processing and launching the shuttle, both at KSC and at the Vandenberg Air Force Base in California. This contract and the features of that contract, I believe, are an important step in bringing down the operating costs of the shuttle and improving its availability for flight on time. The contract is a target, cost per flight, incentive contract. As I said, it affects both the east and the west coast.

It was a unique step and it is the first time that NASA has dedicated to one contractor an entire mission with all the supporting activities required to process, check out, maintain the launch equipment, upgrade the designs, in a total system. The contractor will be working against a broad set of objectives as well as specific and measurable criteria on a mission basis.

The incentive fee of the SPC is designed to provide attractive financial rewards for successful efforts as well as substantial penalties for failure of those efforts. It is based on a cost per flight, on a 3-year average, and one unique feature in order to keep the contractor active in trying to assume a timely effectiveness in that, if there is any problem that occurs outside his jurisdiction that can cost him up to $5 million per occurrence, his fee will not be adjusted. He is motivated to assume that hit, to work that out, and to get on with the job. I am pleased to say that, to date, our expectations of SPC are being realized, the savings are there, and I have the greatest confidence that that contract will assist us as we move forward.

In addition to this contract consolidation, a year earlier we consolidated all the base support activities at KSC, and we achieved in the first year a 14-percent saving over the previous way of doing business. That was in fiscal year 1983, and I expect similar savings in 1984 and 1985 and subsequent years. These contract changes for mission contracts are just the first step of bringing the shuttle into an operational status from the KSC perspective. We now have to take what we have today and evolve it into a mature operating system.

Two prime goals, as we look at it from KSC, one is to achieve the 20-per-year launch rate at KSC by fiscal year 1987 and a launch rate of 4 launches per year at Vandenberg by 1989. In achieving this, we are striving to achieve an orbiter turnaround date of 28 days per flow. We have high confidence that this year we will achieve 35 days per flow capability, and we see ways to bring it down to the 28 days per year. Of paramount importance in achieving that is bringing on the second line of facilities at KSC, pad B, mobile launcher platform No. 3, the upgrade of firing room 4 to support checkout capability, and the operational readiness of the Vandenberg launch site. We have strong motivations, both between ourselves and the Air Force, to keep the two launch activities at Vandenberg and KSC as similar as we possibly can. We can share resources, we can share design capabilities, and thus enhance the operational effectiveness on both coasts. At Kennedy, the critical path for our time is the processing of the orbiter, whereas on the west coast, they stack on the pad the solid rocket boosters and the external tank, as well as orbiter to get into that critical path flow.

In the evolution, we see three major areas we must pay attention to: one, the flight hardware and software maturity, the flight hardware logistics maturity, and the flight hardware processing maturity. Of those three, we, at KSC, have the most control over the flight hardware processing maturity problem. We must work in close cooperation with both Johnson and Marshall to achieve the other two areas. I would like to say that activity is going quite well.

Let me address what I mean by flight hardware and software maturity. We must evolve to a state that we see a reduction from the number of modifications. As we have developed this vehicle, we have found shortcomings in various parts of the design. Dr. Lucas has pointed out some areas in the main engine and external tanks. We are presently modifying the orbiters to beef up some of the wing structure, and we are putting in the modifications required to support the Centaur for Galileo and Solar Polar and subsequent missions.

Those modifications of that type must be reduced and come down to a minimum number if we are going to get our launch rate up with a four-vehicle fleet. I am happy to say that I see that reduction coming, and I think we have excellent cooperation there. Along with that, we must reduce the amount of testing that we do. We realize that we have our best test in the previous flight. We do not have to certify the configuration of the vehicle each time. We only have to retest those areas that were modified where we had problems. We all must become very comfortable with that as the performance criteria and reduce the number of testings, and that evolution is occurring quite rapidly. We must also develop, both between ourselves and the development centers, confidence in the routine processing to minimize the number of special tests and special activities.

The second item is flight hardware logistics maturity. We must have the parts available when we need them, and we must have confidence in those parts. Today, we have on the shelf approximately 80 percent of all the spares we need at the times we need them. The other 20 percent we are in the process of having to rob from another orbiter to put in the fleet to meet the existing flight that is coming up. That has not caused any problems to date, but as the launch rate accelerates, that parts availability must improve. The parts are on order, the systems are in place, and as Mr. Griffin pointed out, we will have that capability within a year or two.

We also must have great confidence in those parts once we take them off the shelf. There will be no question that that part is the identical part to what went into the vehicle, and we can replace it without a large amount of time resourcing its pedigree.

From our standpoint, we must continue in maturing the processing flow at the Kennedy Space Center. We must standardize the processing flow. What I mean by that is that we must come down to a point in time where we know exactly what we have to do to that vehicle each and every time. It is something that has to be planned out months ahead of time, a routine procedure, a routine schedule for it. Some tests will not be done after each and every flight, but we must know exactly what time critical tests must be done and when and plan that into our schedule. SPC has brought onboard Pan American Airlines to assist in that activity using some of the airline's maintenance techniques and technology. We are finding that to be very beneficial.

The next thing we are doing as the launch rate picks up is we are stationizing the work force. In the past, we have moved the work force with the vehicle from the orbiter processing facility to the VAB and to the pad. As the launch rate increases, that becomes to be less effective and less efficient. We are evolving rapidly to a majority of our work force that stays at one location. With the vehicle will move a small flow management team to follow their hardware and track it, and we will have at each location a management team in place to process that hardware. In general terms, if a man's time is required 80 percent of the time or more at a facility, he will stay in that facility. That doesn't mean that the other 20 percent of his time will be wasted. It will be utilized with other jobs as his primary function within that facility. Launch rate and number of hardware is what is driving us in that direction.

We must optimize, third, our processing operations. We must evolve more efficient management and planning techniques. I see no major single thing in that area that is going to cause a major jump in productivity, but it is a continuing evolution, continually streamlining the process.

We must know well in advance what the configuration of a specific flight is going to be. We must work in close cooperation with the cargo manifesting activities at the Johnson, sometimes suggesting that they fly flight A and C, rather than A, B, and C, so that we have minimal amount of mileage to an orbiter in that particular flow. If we work those out with the customers, that will reduce our time and increase our operational effectiveness.

Certain product improvements are required at the same time. Dr. Lucas mentioned, I think, some of those that were being done to the external tank and the solid rocket booster. Those improvements are greatly decreasing the amount of time required to stack the solids and mate it with an external tank and mate it with the orbiter. Similar modifications are being incorporated into the orbiter itself. We, at the Kennedy Space Center, have recently installed floor lifts in the orbiter bay 1 of the orbiter processing facility, have changed I think the first use of that from about a 4-hour operation of leveling the vehicle when we start checking on it to about 8 minutes. We checked that out with the last moving of the orbiter into OPF. Of course, it was going the wrong way; we would rather have seen it coming from the landing facility rather than the launch pad, but we got to check out the capability anyway.

We have incorporated onto launch pad a washdown system to dispose of the SRB exhaust problem in a very effective way rather than a hand washing process, and we are bringing on line new buildings to process the SRB's and their equipment. All of these activities are moving us toward a more cost-effective processing activity for the shuttle.

I see no reasons from the Kennedy standpoint that we cannot reach the launch rate of 24 flights per year, both east and west coast. I would like to say, from a Kennedy standpoint, we are dedicated to achieve that in the timeframe given to us, and I think we can beat our cost objectives as far as Kennedy is concerned for operating the shuttle.

Mr. Chairman, that concludes my summary. I will be happy to answer questions at the appropriate time.

[The prepared statement of Mr. Smith follows:]

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS
August 1, 1984

Statement of

Mr. Richard G. Smith
Director, John F. Kennedy Space Center

National Aeronautics and Space Administration

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to present to you the actions we are taking at the John F. Kennedy Space Center (KSC) to move the Space Transportation System (STS) into the operational era and my assessment of where we are now, where we are going, and how we will get there.

In September 1983, Lockheed Space Operations Company (LSOC) was awarded a contract for shuttle processing at KSC and Vandenberg Air Force Base (VAFB). That procurement, I believe, has provided a contractual arrangement which will improve productivity, increase system capacity, reduce processing time, and reduce target cost per flight while maintaining the existing levels of mission success and safety of the Space Transportation System.

The Shuttle Processing Contract (SPC) is a target cost per flight, incentive fee mission contract to process Space Transportation Systems (STS) both at Kennedy Space Center, Florida, and Vandenberg Launch Site (VLS), California.

It should be noted that a mission contract is a new contracting method for the type of work the shuttle processing activity represents. In a mission contract environment, KSC now assumes a true program management role, exercising management surveillance over the contractor and retaining policy authority while tasking the contractor to work against a set of broad objectives, as well as specific, measurable criteria for each and every mission.

The incentive fee feature of the SPC is intended to provide attractive financial rewards for successful efforts and penalties for unsuccessful results in reducing overall costs per flight and for mission success. This feature of the SPC continuously challenges LSOC to employ up-to-date techniques designed to improve productivity and increase reliability. Changes in operational concepts or configuration of facilities are now clearly a contractor responsibility with KSC retaining overall technical management.

I am pleased with the cost savings already being realized from the SPC in FY 1984, the transition year of the contract. With this experience base, we now fully expect to achieve the projected savings we identified and we are working to see if we can exceed those expected savings. In addition, the recent contract consolidation of KSC base support has produced a cost savings of 14.0 percent in FY 1983 with similar cost savings projected for FY 1984 and FY 1985.

With the advent of the SPC and the mission concept under which it is being administered, I believe the first steps have been taken by KSC to move into the operational era and to enhance the commercialization of space activities. The private sector in the United States is now entering both launch and cargo operations with enthusiasm and resolve.

EVOLUTION OF OPERATIONAL MATURITY

The evolution of the processing activities to Operational Maturity includes consolidation of certain facilities, integration of launch site activities, and the introduction of new operational concepts and management systems, all designed to reduce the processing time at KSC. This morning I will cover only the most significant issues in that plan.

The prime goals NASA has established, however, as part of our evolution plan are:

1. Achieve a launch rate capability of 20 per year at KSC by FY 1987 and a launch rate capability of 4 launches per year at VLS by FY 1989.

2. Achieve a critical path processing time for orbiters at KSC of 28-days workdays.

KSC is committed to achieve a generic turnaround capability of 35 workdays within a year. Incidently, I must add that planned launch rate capacity depends on timely activation of our 2nd line facilities; i.e., Pad B at Launch Complex 39, Mobile Launcher Platform (MLP) #3, Launch Control Center Firing Room #4 and the operational readiness of the Vandenberg Launch Site.

As an associated task, KSC plans to integrate activities which are common between the two coasts to maintain configuration management and operations discipline in similar technical environments. While we will concentrate on those tasks which occur along the orbiter's critical path, we are also conducting analyses on all support activities as a possible source for critical path timeline reductions.

The "critical path" in the processing activity at KSC is defined as the path of the orbiter while the critical path at VLS involves Solid Rocket Booster (SRB) stacking, External Tank and SRB mate and integrated operations flow.

MAJOR ELEMENTS IN ACHIEVING OPERATIONAL MATURITY

There are a number of significant activities which influence the "turnaround" time, that is the time between the landing and next launch of a vehicle. Only a few can be generally discussed today.

Our assessments indicate that the maturing of three major program elements provide the greatest potential for decreasing processing time dependencies. They are:

1. Flight hardware/software maturity
2. Flight hardware logistics maturity
3. Flight hardware processing maturity

Of these factors, only one, that of the flight hardware processing is managed by KSC. Flight hardware/software and flight hardware logistics are responsibilities of the NASA Development Centers and their major development contractors, Rockwell, Rocketdyne, Martin Marietta, and USBI.

I can assure you that our assessments are shared by the Development Centers. Therefore, KSC is handling its own flight hardware processing responsibilities in such a way that these external dependencies are made visible, and are thereby recognized and managed by others in a fashion that benefits the processing flow at KSC and VLS.

Before discussing how KSC intends to achieve flight hardware processing maturity, let us talk briefly about the first two elements.

Flight Hardware/Software Maturity. Flighthardware/software maturity is a major driver leading to a reduction of the overall processing time. It represents the most significant expenditure of technical and management assets to accomplish non-routine work. We see reduction in modifications, reduction in testing, and confidence in our routine processing ability as being essential contributors to that end.

Reduction in Modifications. Orbiter fleet modification projects exist at present for each of the orbiters, heavily affecting our integrated schedules. Modifications that are currently underway are wing modifications designed to strengthen the wing to sustain greater aerodynamics loads and Centaur modifications to accommodate the Centaur System. In the future, we must not only reduce the total number of modifications, but those modifications which are approved must be scheduled well in advance so as to realistically mesh with allocated processing time.

Commitments have been made to a strong Configuration Management Program and to an increased engineering discipline that will, I believe, stem the flow of flight hardware modification requests.

Reduction in Testing. The next element in flight hardware/software maturity development is the reduction of testing. A large amount of time is presently associated with this activity, sometimes causing schedule changes and workforce reassignments. Certainly there is a need for verification of systems performance at various points in the flow, but we must continue to find ways to substantially reduce testing without adverse consequences.

KSC is performing analyses of what we consider redundant testing and will provide recommendations to the Development Centers for consideration.

Confidence in Routine Processing. Finally, we must promote and maintain acceptable confidence levels by the Development Centers in the routine processing activities performed as standard operations during each flow. We have extensive technical reviews to evaluate our progress against major milestones; i.e., Orbiter Processing Facility (OPF) rollout, Vehicle Assemble Building (VAB) stacking operations and similar important events. We must continue to build confidence that routine processing can be the norm, that we can remove and replace malfunctioning standard components with a workable spare without triggering a complete program level review.

I believe NASA is making substantial progress in limiting modifications, reconsidering the need for volume testing, and accepting routine processing as a workable concept -- this is a major influence on the road to reducing turnaround time.

Flight Hardware Logistics Maturity. Flight hardware logistics is the second element that influences reduction of turnaround time. Not only must the right parts be available when needed, but there must be acceptance within the maintenance, operations and engineering organizations that the part is serviceable and can be used without extensive management interaction.

Parts Availability. Although we have not had any major schedule disturbances due to lack of spares, we will continue to have concerns until the spares (on order) have been delivered. Currently 80 percent of spares requirements are being met by logistics inventory.

Although the NASA logistics policy does turn control of Shuttle Logistics over to KSC eventually, I believe NASA should expedite this process to insure the reduction of processing time. We intend to support the Development Centers and their contractors in any efforts which will cause the logistics system to mature at the earliest possible date.

Parts Confidence. The second item needed to achieve logistics maturity is the establishment of such confidence in spare parts reliability within engineering and operating units that on-the-shelf spares will be readily accepted for use with only a minimum of verification testing.

We will work within NASA to establish an inspection program such that on-the-shelf spares can be installed in the flight hardware with a minimal impact on serial processing time.

Flight Hardware Processing Maturity. The last major element in achieving operational era capabilities, and the element that KSC has prime responsibility for, deals with flight hardware processing and the reduction of the turnaround time needed to prepare a Space Transportation System for launch. Achieving this goal calls for the establishment of a new work control concept that addresses all aspects of the processing flow. Finding a method of integrating total program resources and applying it to the processing sequence involves three management concepts which have proven effective elsewhere in the aerospace industry:

1. Standardize the processing flow.
2. Stationize the workforce.
3. Optimize the processing operations.

Standardizing the Processing Flow. In standardizing our processing flow we will start to apply substantial pre-planning efforts to the largest possible number of repetitive operational tasks, thereby increasing routineness and aiding standardization. KSC is developing facility, resource, manpower, and conflict resolution models to enhance our planning for standardizing work activities.

Pre-planned processing operations are published in a Launch Operations Order which defines the vehicle configuration baseline, as well as the routine and non-routine processing tasks scheduled during that flow. In the future, a number of shifts will be dedicated to vehicle modification tasks only and will be pre-planned with the standard number of shifts normally required now for a vehicle to flow through the OPF. We believe this is a practical approach to standardizing work activities.

Finally, in standardizing the processing flow, we must define a maintenance program for both flight hardware and ground support equipment. KSC has started a structured maintenance program for ground systems and facilities. Simultaneously, NASA Development Centers are in the process of establishing maintenance programs for re-usable flight hardware which is processed by us. The SPC's airline team member, Pan American, is playing a vital role in this maintenance plan development project. While we have Operations and Maintenance Instructions (OMI) and are using them to maintain flight hardware, facilities and ground support equipment (GSE), we are lacking an overall time phased maintenance plan that permits us to evaluate the technical and schedule risks to the program caused by maintenance demands or modification actions to either flight hardware/software, GSE or facilities.

Stationizing the Workforce. The second step in reducing processing time is to stationize the workforce. We are implementing this approach by moving from a flow management to a facility management concept, and from dedicated support to matrix support.

Traditionally, the workforce followed the vehicle as it proceeded through the various facilities and test milestones to the launch pad. Our approach, which we have already started to implement, is to change from this flow management practice to a concept which holds a facility manager responsible and accountable for the accomplishment of schedules while the flight hardware is under his control. It forces timely application and economical use of resources assigned to his facility. We will transition to the facility management concept as soon as the launch rate has increased to a point where the worker is required more than 80 percent of the time at that particular work station. This does not mean there is a 20 percent loss of productive time, because employees are cross-utilized within the facility they are assigned to. While Facility Managers are already in place at the Orbiter Processing Facility (OPF), the Vehicle Assembly Building (VAB), the Launch Control Center (LCC), and the Launch Complex 39A (LC-39A), an increase to about 3 vehicles in flow will be needed to totally implement the plan.

We believe that by stationizing the workforce, people will become better skilled in accomplishing routine as well as non-routine tasks, and processing time will be reduced as people, parts and paper no longer move with the vehicle.

To successfully stationize the workforce the Facility Manager will be provided with matrixed resources, in lieu of dedicated support for such needs as quality assurance, logistics, process planning and control, or engineering. The matrix concept will apply for all non-hands-on work and will be made available to the Facility Managers upon request from centralized matrix organizations. For example, there is only one scheduling system and one work control system, a single logistics organization, and a single quality assurance department. This ensures commonality of certain operational practices and relieves the Facility Manager from maintaining a permanent complement of support employees in the face of changing flow requirements. An added benefit of the matrix approach is the achievement of commonality of operations support activities between both launch sites; that is, between KSC in Florida and the VLS in California.

Optimizing Processing Operations. Optimizing processing operations revolves around work control and product improvements.

The work control system must produce output data that addresses financial aspects of requirements, operating level budgets and the identification of individual work packages. Budgets are at the heart of target cost per flight goals. Work packages influence the turnaround time and thereby the performance record against established launch schedules.

The work control system begins its interaction with operations with long-range planning and culminates in closure of a work package. To achieve this, advance planning, resource commitment, implementation, and technical and schedule risk management actions all must combine to work toward the common goal. For example, advance planning is dependent upon the cargo manifest schedules generated by the NASA Program Office at the Johnson Space Center (JSC). Our objective is to have firm planning on a given mission completed nine months in advance of the launch. Requirements for work to be performed should be stabilized at that point to allow us to plan for more cost-efficient operation. The Mission Configuration Product Plan we receive from the JSC will eventually satisfy this need. It defines the configuration of the vehicle to be processed, any modifications to be made and changes to the operations and maintenance documentation needed to effect the modifications.

Certain product improvements are required to achieve the goal of a generic turnaround of 28 workdays. Categories of product improvements include facility modification, ground support equipment modifications, redesign of SRB and external tank hardware that contributes to critical path operations of mating and closeout, redesign of orbiter systems for maintainability, and operations simplification.

The External Tank, Solid Rocket Booster, and Space Shuttle Main Engine projects have planned and budgeted their necessary improvements. Also, several product improvements have already been incorporated at KSC, e.g., floor lifts for leveling the orbiter in the Orbiter Processing Facility Bay 1, pad washdown system for SRB exhaust products, redesign of SRB and external tank buildup/closeout hardware, and payload handling retention fittings. Other product improvements have been approved for implementation and are in work, e.g., new APU servicing cart and remote fluid servicing capability.

KSC is committed to continue its support of the Orbiter project in identifying and evaluating additional improvements that are needed to achieve higher launch rates or to be traded off for cost savings at lower launch rates if the higher rates are not required.

CONCLUSION

I have attempted to give a broad over-view of actions KSC is taking to move the Space Transportation System into an operational era.

Measures discussed today along with others will ensure that a strong operational capability is in place within the next 3 years. I believe this to be a necessary condition in order to make possible the achievement of the operations era launch rates.

KSC, through a series of operational and management actions, is committed to achieving the major goals of reaching planned maximum launch rates on time while simultaneously reducing cost per flight, so that we can indeed compete in the international market while providing safety of flight, reliability to our cargo customers, and utmost efficiency in the utilization of our facilities. There is a significant amount of pressure on both NASA and the Air Force to achieve this end result and to provide launch and landing capabilities and services both at the east coast as well as the west coast of the United States with equal efficiency. I believe we have a sound approach for achieving these goals.

Mr. Chairman, this completes my prepared statement. I would like to introduce Mr. Thomas E. Utsman, Director of Shuttle Management and Operations, who is here at the table with me.

Mr. VOLKMER. Thank you very much.
Dr. Hearth.

STATEMENT OF DR. DONALD P. HEARTH, DIRECTOR, LANGLEY RESEARCH CENTER, ACCOMPANIED BY PAUL HOLLOWAY

Dr. HEARTH. Mr. Chairman and members of the subcommittee, it is a real pleasure for me to be here today to represent the research and advanced technology portions of NASA. With your approval, I will submit my written testimony for the record and briefly summarize that testimony.

First of all, I think it goes without saying that the space shuttle is a marvelous flying machine. It is a product of a 10-year development cycle. From my point of view, it is also a product—and we should remember this—of an advanced technology program that dates back into the 1960's, examples being lifting body research at Langley and Dryden, advanced chemical rocket propulsion at Marshall, advanced thermal protection system work at Ames and at Langley.

Our task today—that is, in the research and technology side of the agency—is to attempt to anticipate the future, to pursue advanced technologies to meet those perceived needs, and at the same time, to search for new opportunities resulting from advanced technology. We have a modest program in the agency today funded by the Office of Aeronautics and Space Technology in the agency to pursue advanced technologies for future launch vehicles. In my testimony, I summarize what we have called, for the sake of our testimony, Shuttle II, which is a next generation, as we would say it today, of the shuttle replacement vehicle early in the next century.

These remarks are just to briefly describe what such a vehicle might be like. It may be a one-stage vehicle. The technologies are moving along to the point that, depending on the payload size and the type of maneuvering capability you need in Earth orbit, that we could conceive of a recoverable one-stage vehicle. On the other hand, again, depending on those same factors, it might be a two-stage device, similar to what we have today except it would be—we would anticipate that it would be fully recoverable; that is, both stages would be recoverable. We would not anticipate the use of solid rocket propulsion, but rather the use of a duel fuel rocket propulsion system using liquid hydrogen and liquid oxygen similar to the main engines of the shuttle today, but also a liquid oxygen high pressure hydrocarbon rocket propulsion system. We would not envision an external tank, but rather, as I said before, all portions of the vehicle would be recoverable. There would be other advanced technologies in such a system which would not be visible to the eyes, such as the use of high temperature composite materials, such as carbon-carbon, which is certainly very attractive, lightweight propellant tanks, and from an aerodynamic and control point of view, a control-configured vehicle.

Even though we have looked at various modes of liftoff and landing, we would anticipate that it would probably continue to be launched vertically and landed horizontally. The objective, of course, would be to end up with a vehicle with significantly better performance and much improved economics. The technologies that are being pursued today that we see pursuing and the way we see them maturing in the future, we would anticipate a vehicle that would be significantly smaller than the shuttle in terms of weight, which is the important factor when we come to economics, perhaps less than one-half the dry weight of the current vehicle with the same type of payload.

We are not, of course, advocating the development of such a vehicle today, rather, continuing an advanced technology program to permit the development of such a vehicle in the future. As I indicated in the testimony, that while the thrust of these comments are referring to a new generation vehicle, our experience has shown that one gets a great deal of spinoff from advanced technology programs of this type that can be used as, if you will, product improvement items in current systems.

That concludes my summary, Mr. Chairman. Even though I promised my colleagues I would filibuster so that they wouldn't have to answer any questions, I think I will stop here.

[The perpared statement of Dr. Hearth follows:]

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS
August 1, 1984

Statement of

Dr. Donald P. Hearth
Director, Langley Research Center

National Aeronautics and Space Administration

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

I welcome this opportunity to meet with you as part of this NASA Field Center Panel and to participate in your review of Space Shuttle Requirements, Operations, and Future Plans. Sponsored by the NASA Office of Aeronautics and Space Technology (OAST), the Langley Research Center as well as other NASA Centers is concerned with the advancement of technologies which support the Nation's future space activities. OAST technology planning for space transportation encompasses a broad range of potential future systems in the two major categories of Earth-to-orbit transport vehicles and orbit transfer vehicles as illustrated in my first chart entitled "Space Transportation System Scenario."

This chart illustrates both existing and potential future systems which may be required to meet a variety of future space transportation needs. These systems include Shuttle enhancements, Shuttle derivatives, upper stages, and new launch systems. Today, however, I will focus my remarks on our technology planning for the next generation Space Shuttle, what is labeled on the scenario chart as "Advanced Launch Vehicle," or what I will refer to as "Shuttle II."

I want to underscore the concept of planning. There are no commitments by NASA or the Administration to the development of any of the advanced concepts I will discuss. Funding in the NASA budget projections is for advanced technology activities only and not for development.

LONG-TERM PLANNING FOR ADVANCED SPACE SHUTTLES

Technology Lead-Time Requirements

The highly successful first flight of the Space Shuttle was preceded by an intensive development program which took almost 10 years. The technology work which allowed us to undertake that development program in the early 70's with a high degree of confidence actually began more than 20 years ago. Key technologies in areas of lifting entry and advanced cryogenic rocket propulsion, as well as some promising technology options which didn't reach technology readiness in time to be used on the Space Shuttle such as metallic thermal protection systems, were pursued during the 60's. One hundred percent success in converting technology to applications is, of course, not to be expected. But the key point here as illustrated in my second chart is that many critical technology areas for space transportation systems must be initiated some 15 to 20 years prior to first flight application.That period of 15 to 20 years prior to an initial operational date is when there is the greatest technology leverage on a new vehicle system. Although today's technology programs can often have significant near-term payoff as enhancements for existing systems, they have the potential for the greatest leverage on new systems introduced after the year 2000, systems for the 21st century. That is also the time frame when the Space Shuttle will have reached its original design lifetime and will either need modifications for extended life or will have to be replaced by a new system.

Goals, Needs, and Concepts

The goal for Shuttle II would be to provide a major advancement in Earth-to-orbit transportation efficiency through lightweight structures and high performance engines; productivity advancements through rapid turnaround and reduced manpower; and cost reductions for all program phases through reusability, long life, and increased use of automation in design and manufacturing as well as in operations. The justification for this system could be: (1) to maintain our national position in economics, leadership, and security in the face of international competition; (2) to enable expanded realization of the space potential; (3) to foster new or expand existing space commercialization ventures including that of space transportation; (4) to provide increased capacity to meet demand growth; and/or (5) to furnish an alternative to Shuttle life and/or a capacity extension.Based on our extensive studies of potential advanced concepts, we have found that Shuttle II should be built on the concepts, technologies, systems, and infrastructure of our current space transportation system. To achieve lower operational costs, Shuttle II must be fully reusable, and advanced technologies will be required to reach the needed levels of high operational productivity, high performance, and low development, production, and operational costs.

VEHICLE CONCEPT DESCRIPTIONS

The most promising Shuttle II concepts which we have examined are derived directly from the Shuttle legacy. They are winged vehicles strongly resembling the Space Shuttle Orbiter, they will likely take off vertically and land horizontally like the Shuttle, and they will probably utilize all-liquid rocket propulsion with a direct inheritance from the Space Shuttle Orbiter's main engines. With the addition of incremental technology advancements, either of two basic configuration options appear attractive depending on the mission requirements and available technology. These options are two-stage and single-stage concepts.When sized for a Shuttle-class payload, chosen for a reasonable compromise between development and operational costs, these concepts have an overall size similar to the Space Shuttle launch vehicle and an overall size and unfueled weight comparable to a DC-10 transport aircraft as illustrated in my third chart. The solid rocket boosters used on the Space Shuttle are replaced by liquid rocket engines and all propellants are carried in reusable tanks inside the vehicles. Prior to final fueling, ground handling of these vehicles can be much like that for aircraft. With the addition of an vertical erection system at the pad, the need for two major facilities required for the Space Shuttle, the Vertical Assembly Building (VAB) and the Mobile Launch Platform (MLP), can be eliminated. With over twice the payload fraction based on unfueled weight compared to the Space Shuttle, these new fully reusable systems are considerably more efficient, they have 20 to 35 percent lower gross weight, and burn less costly and cleaner propellants. Features of these two concept options are described in the next two sections.

Advanced Two-Stage Concepts

Advanced two-stage concepts are similar to concepts studied in the early Space Shuttle Program but are smaller and much more efficient. These two-stage concepts have rather low technological and programmatic risks and are easily scalable to large payload sizes if there is such a requirement.A typical two-stage concept is illustrated in the computer drawings on my fourth chart. In this parallel-staging concept, the engines on both stages are fueled from the booster tanks during the early part of the ascent by using a propellant crossfeed system like the Space Shuttle system which feeds propellants from the external tank to the orbiter engines. This allows the advanced orbiter to be fully fueled at staging while also permitting the use of the orbiter propulsion system during the initial phases of the ascent trajectory. The payload shroud on top of the orbiter can be changed to adapt to the physical characteristics of a variety of payloads.

Advanced Single-Stage Concepts

Single-stage concepts are a Shuttle II option which was not previously feasible because the technology just was not ready. Advanced technology, however, can make these concepts both feasible and very attractive from a cost standpoint. My fifth chart illustrates a typical single-stage concept. Although requiring more advanced technology and being more sensitive to weight growth problems than the two-stage vehicle, single-stage systems have the potential for larger cost payoffs. Because of the simplicity of having a single vehicle element, lower development and production costs than for the two-stage concept are possible. Also, the operations would be greatly simplified, allowing significant manpower reductions. The combined effects of reusability, design for both performance and operations, and incorporation of advanced technologies for operations, performance, and cost give these concepts the potential for a factor of ten reduction in operations costs as compared to the Space Shuttle. With the 1-week ground turn-around time which appears achievable for this advanced concept, a single vehicle could exceed the overall launch capacity of a fleet of four of our current Space Shuttles.

A COMMON TECHNOLOGY PROGRAM

The single-stage and two-stage options for Shuttle II share virtually the same technology requirements; therefore a near-term selection of a concept is not required prior to developing these technologies. The key technologies include: those focused on high performance to lighten vehicle structures and engines and to improve rocket propulsion efficiency; those focused on operational productivity to shorten ground turnaround time, improve vehicle serviceability, and reduce manpower through automation; and those technologies to reduce costs in all phases of the program such as automation in the design, development, and manufacture program phases; reduction of software costs for operations; and extension of component lifetimes.

A key part of our advanced concept studies has been to assess the potential economic impacts of various advanced technologies. Certain technologies have very high economic leverage, whereas some can have a negative payoff. For instance, a large investment could be required to achieve only a marginally small benefit. By concentrating on those high leverage areas, the greatest overall benefits can be achieved in operations costs as well as total life-cycle costs. My next chart entitled "High Leverage Technologies" lists areas which our studies have shown to have strong payoffs based on life-cycle-cost reductions. Three areas of structures and materials (the primary vehicle structure, the propellant technology and the thermal protection system), one of propulsion (dual-fuel rocket systems), and one of aerodynamics (control-configured design) are indicated along with the focus of the technology programs and their potential advancement provided adequate research programs are continued. These program areas are listed in order of their expected benefit to an advanced vehicle system. I have selected two of the areas having the highest economic leverage to discuss further as examples, those are structures and materials, and rocket propulsion.

Structures Technologies

Studies have consistently shown that the highest payoff area for advanced technology is advanced structures and materials. Advanced lightweight, serviceable structures are essential to the performance and operations goals of Shuttle II. Achieving the required low weight within a thermostructure exposed to the extremes of low temperature cryogenic propellants and the high temperatures of atmospheric entry while also meeting operational requirements of serviceability, reusability, and all-weather operations is quite a challenge for both the structural design and the materials. Our studies show that an effective overall weight reduction of 20 percent relative to Space Shuttle structures is feasible for Shuttle II. The impact of that advancement on a single-stage vehicle is a reduction of as much as 50 percent in the vehicle unfueled weight.

Advanced materials are utilized for body structure, propellant tank insulation, thermal protection systems, and potentially in the propellant tanks. Programs at the Langley Research Center are focusing on advanced composite materials with application to both aircraft and spacecraft and on advanced metallic thermal protection systems which may provide improved operational durability over the current Space Shuttle materials. Another Langley research program is developing advanced carbon-carbon composite materials with the potential for hot structure applications such as required in aerodynamic control surface capability with temperatures up to 2700 degrees F. We currently have rather limited research programs in the needed areas of warm structure composites, reusable cryogenic insulation materials, and new tank materials and expect to expand this effort in the future.

Structural design for long life, up to 500 flights for Shuttle II, presents special problems for inspections, maintenance, and repairs. Those types of concerns have resulted in the aeroshell design concept illustrated on my next chart, which was developed in studies at the Langley Research Center. In this concept, efficient structural design is achieved by the mating of two separate structures: one designed with the tanks and engine elements of the propulsion systems as a unit, whereas the other is designed with the aerodynamic shell, payload bay, and crew compartment. This arrangement permits the periodic demating and inspection of the propellant tanks to provide adequate design safety. This concept also provides excellent access to many components which may require servicing and repair and the weight is comparable with more conventional structural arrangements.

Advanced Rocket Propulsion Technology

Propulsion requirements dominate the overall design of these vehicles with over 90 percent of the gross weight related to the propulsion system and with the dominant physical and structural feature being the propellant tanks. It is not surprising, therefore, that propulsion is a high leverage technology. The challenges for propulsion are to provide high performance (in terms of specific impulse) at low system weight (including engines, tankage, and propellants) with long life and good serviceability.The Space Shuttle Main Engine (SSME) will likely be used directly or in some derivative form for Shuttle II. Therefore, the continued efforts to improve the lifetime of the SSME, as being pursued in programs at Marshall Space Flight

Center, have high leverage payoffs for Shuttle II as well as for the current Shuttle.The use of advanced rocket engines which burn hydrocarbon fuels, in conjunction with the Space Shuttle engine using liquid hydrogen, provides significant advantages to either of the Shuttle II concepts. Although the hydrocarbon-fueled engines produce lower performance as measured by specific impulse, higher propellant densities and lower engine weights can result in large reductions in overall vehicle size, unfueled weight, and cost. My next chart illustrates a large 40 percent reduction in unfueled weight and 15 percent reduction in gross weight for a single-stage concept as the result of a rather modest advance in rocket technology for hydrocarbon fuels.The Marshall Space Flight Center is leading studies and technology programs addressing advanced hydrocarbon fueled rocket engines. These programs are presently limited to small scale laboratory research. This area needs to be expanded in future years to the component and systems level of research in order to meet the objectives I have described.

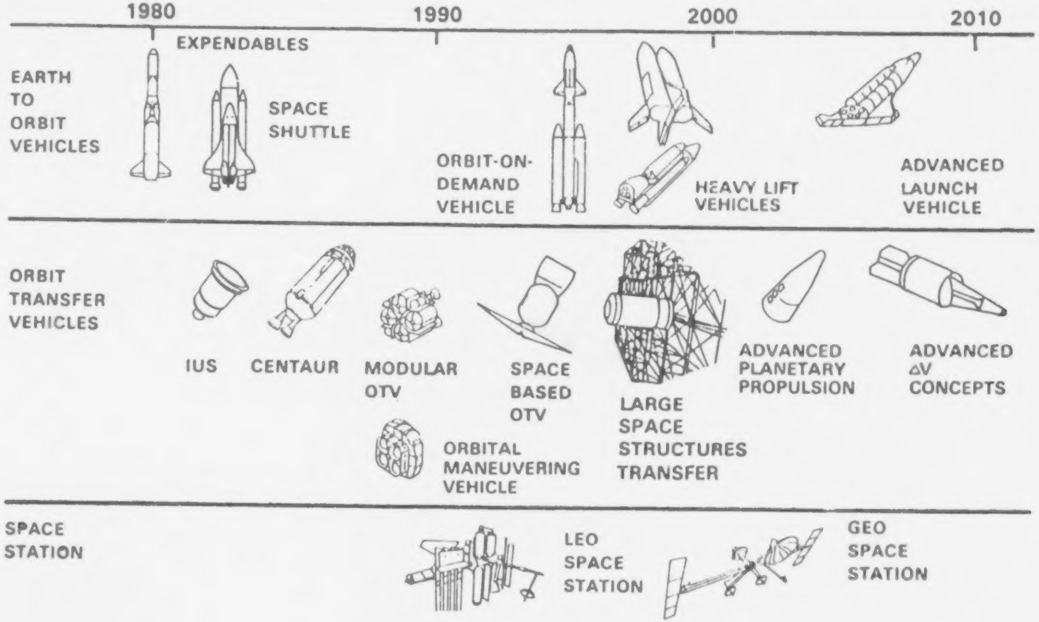
Near-Term Benefits

Experience has shown that, although these technology programs are focused on advanced vehicles, they often turn out to have potential near-term payoffs in such areas as Shuttle enhancements. Some examples of far-term oriented technologies which may be considered as possible enhancements for Space Shuttle are: advanced carbon-carbon hot structure for orbiter body flap and ailerons; orbiter aerodynamic and flight control enhancement using tip-fin controllers; and hydrocarbon fueled rocket engines for Shuttle derivative launch vehicles.

SUMMARY AND CONCLUSIONS

As you know, the Space Shuttle represents a giant step forward in our capabilities in space. However, the Space Shuttle is not our last step in launch vehicles. Precisely when and for what reasons the next step will be needed is, of course, uncertain at this time. However, we must be prepared with reasonable options when that need arises. Although a number of years in the future, we must continue to identify, plan, and develop the critical technologies for the next major step in space transportation just as we did in the 1960's prior to building the Space Shuttle.

SPACE TRANSPORTATION SYSTEM SCENARIO


1980
1990
2000
2010
EARTH TO ORBIT VEHICLES
EXPENDABLES
SPACE SHUTTLE
ORBIT-ON-DEMAND VEHICLE
HEAVY LIFT VEHICLES
ADVANCED LAUNCH VEHICLE
ORBIT TRANSFER VEHICLES
IUS
CENTAUR
MODULAR OTV
SPACE BASED OTV
ORBITAL MANEUVERING VEHICLE
LARGE SPACE STRUCTURES TRANSFER
ADVANCED PLANETARY PROPULSION
ADVANCED ΔV CONCEPTS
SPACE STATION
LEO SPACE STATION
GEO SPACE STATION

NASA

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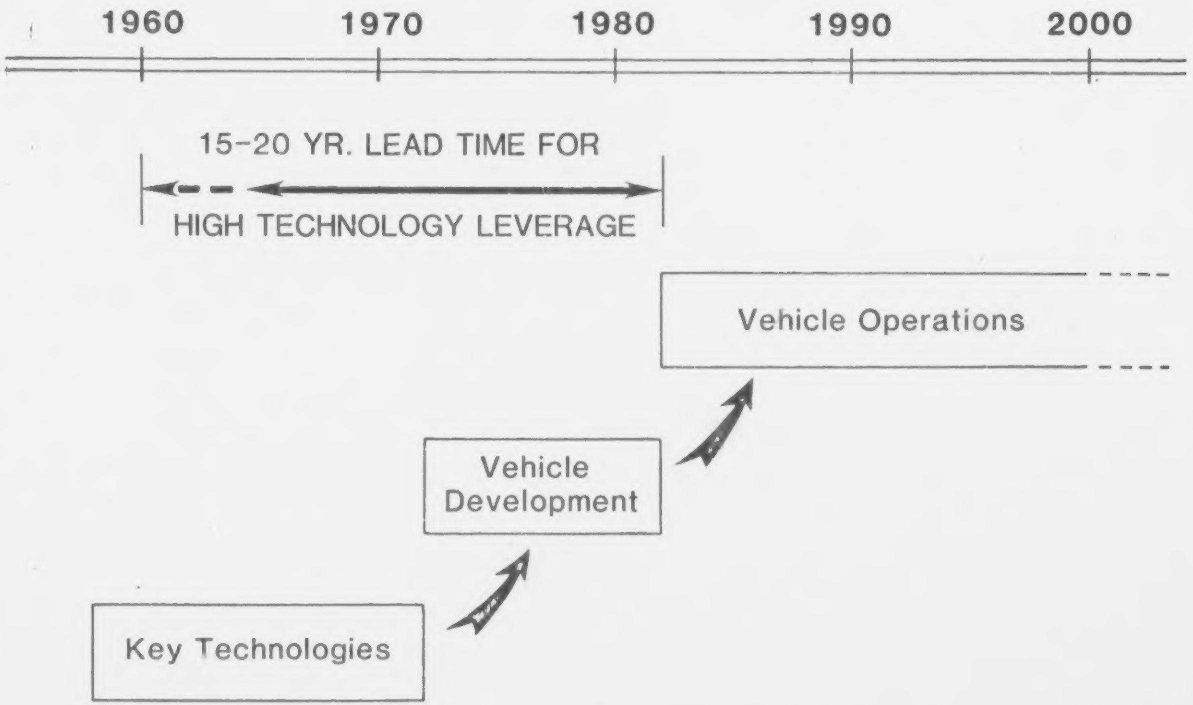
Rev. 11-7-83

TECHNOLOGY LEAD TIMES

SPACE SHUTTLE PROGRAM



1960
1970
1980
1990
2000

15-20 YR. LEAD TIME FOR
HIGH TECHNOLOGY LEVERAGE

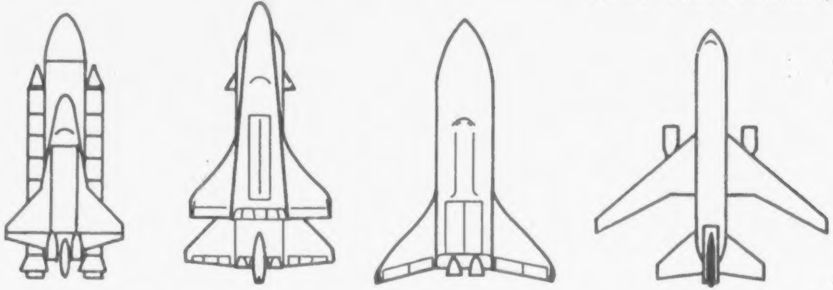
Vehicle Operations

Vehicle
Development

Key Technologies

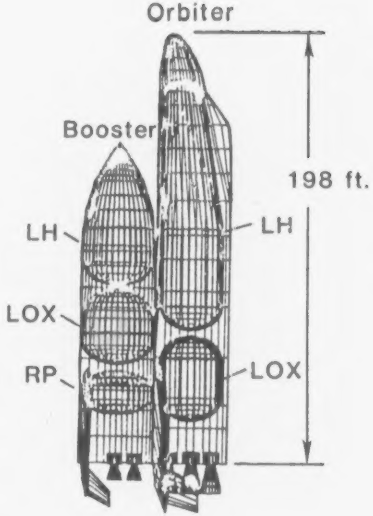
COMPARISON OF ADVANCED TECHNOLOGY LAUNCH VEHICLES

65,000 lb. PAYLOAD

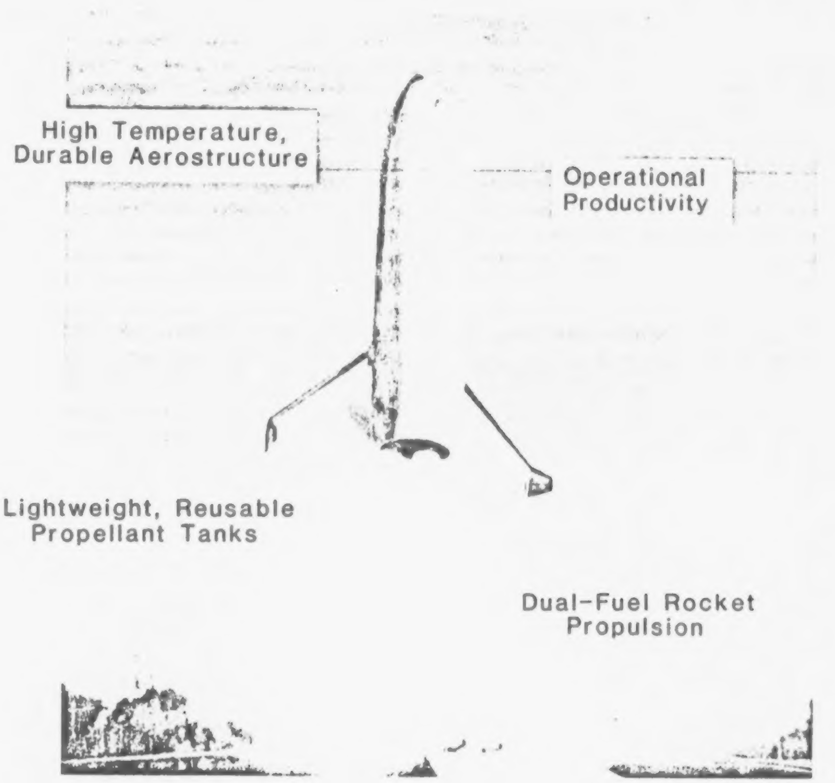


	Shuttle	Two-Stage	Single-Stage	DC-10 (For Reference)
Dry Weight, lbs.	600,000	290,000	260,000	260,000
Payload/Dry Weight, %	11	24	26	

ADVANCED TWO-STAGE LAUNCH VEHICLE


Orbiter
Booster
198 ft.
LH
LOX
RP
LH
LOX

ADVANCED SINGLE-STAGE LAUNCH VEHICLE

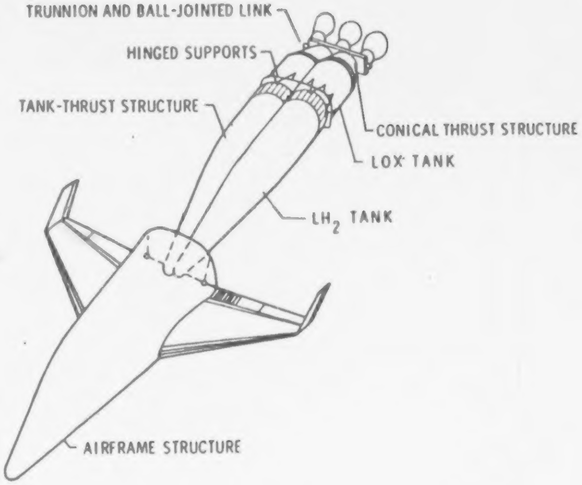

High Temperature, Durable Aerostructure
Operational Productivity
Lightweight, Reusable Propellant Tanks
Dual-Fuel Rocket Propulsion

HIGH LEVERAGE TECHNOLOGIES

	FOCUS	TECHNOLOGY ADVANCEMENT
Wing, Body and Thrust Structure	Composite Materials Warm Structure	-15% Weight
Dual-Fuel Rocket Propulsion	Hydrocarbon-Fueled Engines	+50% Bulk Density +30% Thrust-to-Weight -7% Specific Impulse
Propellant Tankage	Reusability Under Thermal Cycles	-10% Weight
Aerodynamics and Flight Control	Control Configured Design	-8% Weight
Thermal Protection Systems	High Temperature Materials Hot Structure	-10% Weight Reduced Maintenance

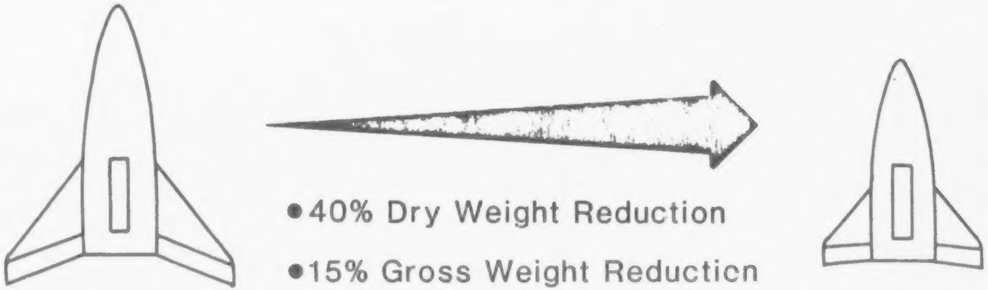
ADVANCED STRUCTURAL CONCEPTS

- Lightweight Reusable Propellant Tanks
- Composite Materials for "Cold" and "Warm" Applications
- Durable, All-Weather Thermal Protection


TRUNNION AND BALL-JOINTED LINK
HINGED SUPPORTS
TANK-THRUST STRUCTURE
CONICAL THRUST STRUCTURE
LOX TANK
LH$_2$ TANK
AIRFRAME STRUCTURE

AEROSHELL CONCEPT

ADVANCED ROCKET PROPULSION TECHNOLOGY



SINGLE FUEL

DUAL FUEL

- 40% Dry Weight Reduction
- 15% Gross Weight Reduction

Advanced Space Shuttle
Main Engines (SSME)

Advanced SSME's
+
Advanced
LOX/Hydrocarbon

Mr. VOLKMER. Thank you very much.

We will now open for questions. The gentleman from California, Mr. Brown.

Mr. BROWN. I feel a little hazy about this situation with regard to additional upper stages that you mentioned being planned. I wonder if you could give me just a rough picture of these upper stages so I can identify them in my own mind a little bit better?

Mr. GRIFFIN. Sir, I guess of course our newest upper stage that we will use next will be the Centaur vehicle which, of course, is a liquid oxygen, liquid hydrogen stage capable of pushing a very heavy weight either to higher orbits or interplanetary type missions.

Mr. BROWN. Is it primarily for use in the scientific missions, interplanetary missions?

Mr. GRIFFIN. So far, that is the basic thrust, but I think it will be soon followed by other uses. The TOS, or the transfer orbit stage, is a smaller vehicle that is being developed commercially. That will come on line—I am not quite sure when. Maybe Glynn Lunney could help me here—but would push a smaller class of payload to a higher orbit.

Mr. BROWN. To geostationary orbit?

Mr. GRIFFIN. It could at the right weight. Again, the Delta second stage is now in early planning. It is a liquid propellant. The TOS is, incidentally, solid. The Delta upper stage is a liquid stage. It will be available even later.

There are a number of other considerations being looked at by commercial companies that are looking at bringing a stage to mate with a satellite and then brought to the shuttle as an integrated payload. It really is the free enterprise market at work of people figuring out a better way to build a mouse trap and then capitalizing on their development to capture more satellites, if you will.

Mr. BROWN. How do these vary in terms of dimensions and the propulsion systems, too? You mentioned some are liquid, some are solid.

Mr. GRIFFIN. I believe I would like to ask Glynn to step up and discuss those a little bit in detail for you.

Mr. LUNNEY. I am not sure I can recall them all in specific, but the Centaur, of course, is the biggest one, and it generally deals with the class of payload that is in the 12,000 pounds of geosync. To go down to the bottom end, the PAM-D's that we fly today support a satellite at geosync of about 1,200 pounds or thereabouts. PAM-D-II is upgrading that to on the order of 1,500 pounds. Atlas Centaurs, for example, like we use for the INDSAT system today, put about a 2,000 or 2,200 pound satellite on orbit, that is in an ELV configuration. The IUS, to take that one step further, is 5,000 pounds in orbit, so the present PAM's put about 1,200, the Centaur puts 2,200, and IUS puts 5,000.

Jerry mentioned a number of these new stages which are emerging, most of which are at commercial initiative, not the Government's initiative. They are generally targeted—some of them are smaller and they come in a variety of configurations where you can put them together in different ways, but they are generally targeted to take care of, for example, satellites roughly in the Atlas-Centaur to larger than the IUS class. So, you are probably dealing with ranges of payloads from on the order of 8,000 on the top side down to maybe 1,500 on the bottom side, and in some cases, they might even be flown in stacked configurations, that is, perhaps, two-on-one flight. So, there is a whole range of intermediate stages that are being considered by various commercial companies, and they fall in between the Centaur stage and the PAM.

Mr. **Brown**. That is the picture I was trying to get. Now, how do they—they are all compatible with the shuttle bay, aren't they?

Mr. **Griffin**. Yes.

Mr. **Brown**. Do they fully occupy the bay? Does the Centaur fully occupy it?

Mr. **Griffin**. No, the Centaur doesn't. Oh, yes, with its payload it does.

Mr. **Brown**. But the smaller ones could be launched with other payloads in the bay.

Mr. **Griffin**. Yes, sir.

Mr. **Brown**. What I am trying to do is to fit this into the general concept of a maneuverable orbital vehicle. It seems to be one of the things that may be needed down the road a ways, either manned or unmanned, and none of these fit into that category particularly, do they?

Mr. **Griffin**. No, sir, it does not, and maybe Bill Lucas will want to add something here, but we are now in a phase B for an Orbital Maneuvering Vehicle which would be developed to be Shuttle compatible and also later used on the Space Station to maneuver cargo, and following that, the OTV, the Orbital Transfer Vehicle, which is in a phase A or about a phase A. That could be manned or unmanned.

Mr. **Brown**. I need to separate these concepts in my mind because I don't deal with them often enough to keep them all separate as I should.

Mr. **Griffin**. Mr. Brown, I might suggest that we provide for the record—we could give you a one-pager that might really help you on that.

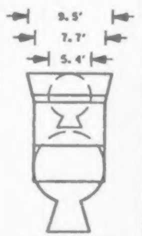
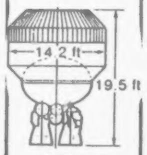
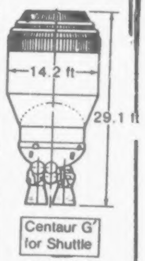
Mr. **Brown**. I think I would appreciate it if you could do that. It might be helpful to some of the other members, too.

Mr. **Griffin**. All right, sir.

[Material to be supplied follows:]

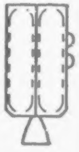
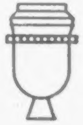
The enclosed charts show the difference between the existing and proposed upper stages.

UPPER STAGES (EXISTING)

CHARACTERISTICS	PAM D	PAM A	PAM D-II	IUS (TWO-STAGE))	CENTAUR G	CENTAUR G'
STAGE: MANUFACTURER • LENGTH FT • DIAMETER FT	MDAC 7.75 4.4	MDAC 7.5 4.4	MDAC 6.5 5.3	BAC 16.4 9.5	G.D. 19.5 14.2	G.D. 29.1 14.2
ENGINE: MANUFACTURER • TYPE • NUMBER • FUEL • COMPOSITION	THIOKOL (STAR 48) 1 SOLID TP-H-3340	THIOKOL (MINUTE MAN 3) 1 SOLID AWS-3066	THIOKOL (PAM D-II) 1 SOLID	CSD L-MOTOR 1 S-MOTOR 1 SOLID HTPB	PRATT-WHITTNEY RL10-3-3B 2 LH_2&LO_2 6:1	PRATT-WHITTNEY RL10-3-3A 2 LH_2&LO_2 5:1
TOTAL THRUST LBS SPECIFIC IMPULSE SEC BURN TIME SEC	14,900 285.6 85.0	35,220 274.3 59.5	17,600	41,621 17,165 292.6 304.1 153 104	30,000(2X15,000) 440.4 436	33,000(2X16,500) 446.4 609
STAGE: PAD WEIGHT LBS • IMPULSE PROPELLENT WEIGHT LBS • BURN-OUT WEIGHT LBS • AIRBORNE SUPPORT EQUIP. WT LBS	4,816 4,400 416 2,505	8,261 7,560 701 4,590	12,270 } 7,692	32.542 21,400 6,060 2,476 2,228 8,111	37,517 29,718 7,799 9,126	51,760 45,085 6,760 9,748
PAYLOAD^1, TO GEO - ONE WAY STAGE (2,2a) LBS • TO GEO TRANSFER ORBIT (GTO) LBS	~1400 (REQS. KICKSTAGE) 2,750	~ 2200 (REQS. KICKSTAGE) 4,295	~ 2000 (REQS. KICKSTAGE) 4,160	4926	10,200^2 10,200^{2A}	20,400^2 14,560^{2A} 26,000
ILLUSTRATION: 1. REF: 28.5° INCLINATION & 150 N.M. CIRCULAR 2. STAGE PROPELLENT FULL 2a. STAGE, PROPELLENT, PAYLOAD, AND A.S.E. LIMITED TO 65K	PAM D	PAM A	PAM D-II	 IUS (TWO-STAGE)	 CENTAUR G	 CENTAUR G'
SCHEDULE: START DATE • OPERATIONAL DATE • LAUNCH RATE (FLTS/YEAR)	1976 1982 TBD	1977 TBD	1982 1985 TBD	1978 1982 TBD	1982 1987 TBD	1982 1986 TBD
TYPE OF DEVELOPMENT SPONSOR	COMMERCIAL DEVELOPMENT MDAC	COMMERCIAL DEVELOPMENT MDAC	COMMERCIAL DEVELOPMENT MDAC	US GOVT USAF	US GOVT NASA	US GOVT NASA

0297.ART.7

UPPER STAGES (PROPOSED)

CHARACTERISTICS		OMV	IRIS	SCOTS	DTS	STV	TOS	TOS/AMS	
STAGE: MANUFACTURER		TO BE SELECTED	AERITALIA	RCA ASTROTECH	MDAC	BRITISH AEROSPACE	MMC	MMC	
• LENGTH	FT	3.3	7.9	9.1	20.3		10.8	16.95	
• DIAMETER	FT	15.0	4.9	6.0	10.5	IN STUDY	11.3	10.0	
ENGINE: MANUFACTURER			BPD DIFESA SPAZIO	WASATCH	OMS-E		CSD	1ST STAGE CSD	2ND STAGE ROCKETDYNE
• TYPE				63-E					
• NUMBER		8	1	1			1	1	1
• FUEL		N_2O_4/MMH	SOLID	SOLID	N_2O_4/MMH	N_2O_4/MMH	SOLID	SOLID	N_2O_4/MMH/N_2O_4
• COMPOSITION		1::1.69	HTPB	HTPB	1::1.65		HTPB	HTPB	1::1.65
TOTAL THRUST	LBS	800		22,500	6,100		41,621	41,621	2,650
SPECIFIC IMPULSE	SEC	310	290.8	298	301	~ 310	292.6	291.4	315
BURN TIME	SEC			125			153	153	1,100
STAGE: PAD WEIGHT	LBS	10,496	4,035	16,045	51,100		24,116	34,645	
• IMPULSE PROPELLENT WEIGHT	LBS	6,566	3,467	8,983	44,105	IN STUDY	21,400	21,400	8,570
• BURN-OUT WEIGHT	LBS	3,930	568	1,062	6,985		2,623	2,042	2,320
• AIRBORNE SUPPORT EQUIP. WT	LBS	144	2,105	2,700	4,350		3,620	4,175	
PAYLOAD[1]: TO GEO - ONE WAY STAGE (2, 2a)	LBS	~ 1500 FPS FOR DELIVERY AND/OR RETRIEVAL WITHIN 1500 NM OF THE SHUTTLE	1,000	2500 (REQS, KICKSTAGE)	7,500	ESTIMATED 2,500-4,000	N/A	6,500	
• TO GEO TRANSFER ORBIT (GTO)	LBS		1,982	5,500	18,500	4000-8000	13,000		
ILLUSTRATION: 1. REF: 28.5° INCLINATION & 150 N.M. CIRCULAR 2. STAGE PROPELLENT FULL 2a. STAGE, PROPELLENT, PAYLOAD, AND A.S.E. LIMITED TO 65K		 OMV	 IRIS	 SCOTS	 DTS	IN STUDY	 TOS	 TOS/AMS	
SCHEDULE: START DATE		1986	1987	1984	1986	TBD	1982	1982	
• OPERATIONAL DATE		1990	TBD	1986	TBD		1986	1987	
• LAUNCH RATE (FLTS/YEAR)		TBD	TBD	TBD	TBD		TBD	TBD	
TYPE OF DEVELOPMENT		US GOVT PHASE B STUDIES	COMMERCIAL DEVELOPMENT	COMMERCIAL DEVELOPMENT	COMMERCIAL DEVELOPMENT	COMMERCIAL DEVELOPMENT	COMMERCIAL DEVELOPMENT	COMMERCIAL DEVELOPMENT	
SPONSOR		LTV, MMC, TRW	ITALY	RCA ASTROTECH	ASTROTECH INC	SCOTT SCIENCE & TECHNOLOGY	ORBITAL SCIENCES CORP	ORBITAL SCIENCES CORP	

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Mr. **Brown**. We appreciate that.

I have no further questions, Mr. Chairman.

Mr. **Volkmer**. All right.

Mr. MacKay?

Mr. **MacKay**. Dr. Hearth, I was very interested in your written testimony where you talk about the advances that are clearly foreseeable. It would appear to me that you have within your grasp the ability to go forward and that your planning, as shown on some of your charts, shows an orbit on demand vehicle, heavy lift vehicles. It seems to me it is clearly part of what has been your assigned task for a number of years and that you are well into it.

How would the initiation now of a separate program, almost competing program, in another agency affect you and the talent that you have assembled and morale and momentum and that kind of thing?

Dr. **Hearth**. I don't think it would particularly have an adverse effect on morale, Mr. MacKay. Our task is to try to look as far into the future as we can see and be pursuing those technologies that will permit that kind of a future to happen. We are driving forward on a number of technologies that I have mentioned, some of which are applicable to orbital transfer vehicles which goes back to part of Mr. Brown's question, some of which deal with heavy lift vehicles which might be required for a variety of users such as the space defense initiative. I think pursuing technologies as we are and as other folks in NASA and industry are would not be particularly adversely affected by the proposal from the Department of Defense.

Mr. **MacKay**. So, it wouldn't affect your program one way or the other.

Dr. **Hearth**. No. You see, to pursue a new generation shuttle, which is primarily what I talk about in that written testimony, we wouldn't be in the position to perceive of the development of such a device for probably another 6 to 8 years, because the technologies simply are not at that point where you commit to the development of a program.

Mr. **MacKay**. But if money is going to be spent developing rocket engines, would it not enable you to put your rocket technology forward at a faster rate if, while doing the work on ELV's now, you could be also putting forward the state of the art with rocket engine design? That seems to be——

Dr. **Hearth**. That is certainly true.

Mr. **Brown**. Would the gentleman indulge me just a little bit?

Mr. **MacKay**. Mr. Brown?

Mr. **Brown**. Dr. Hearth, we heard some testimony 2 days ago. I don't think it was in this committee, but in another committee, from General Abrahamson about some new technological developments under the space defense initiative where they were not necessarily welcome. One I recall was an electromagnetic propulsion device, what I think in the science fiction literature would be called a mass thruster. Are you doing any research in that as a way of transferring orbital loads?

Dr. **Hearth**. Well, we at Langley——

Mr. **Brown**. What he was contemplating was its use as a space weapon, but I was looking at the civilian uses.

Dr. **Hearth**. We, at Langley, are not, because we are not in the propulsion business. Dr. Lucas might want to comment in terms of what is going on at Marshall in that area or in any similar area. Bill, could you comment on that? I can't.

Dr. **Lucas**. Yes, we are not presently studying that at Marshall. However, we have considered the prospects of that in the past, and that would be a propulsion system that should be considered for transfer of energy out in orbit itself. There was a study one time having to do with a space station and transporting lunar materials to the space station in that manner.

Mr. **Brown**. Precisely. What I am really trying to get at here is the possible relationship between civilian and military programs and whether we are getting the full synergism on that that we ought to be getting.

Dr. **Hearth**. Well, I would like to comment on that, Mr. Brown, if I might, and Dr. Lucas might want to add. At Langley and at many other parts of NASA, we have a long tradition of working very closely from a technical point of view with our counterparts in the military establishment. At Langley, that partnership goes back to World War I and the development of aircraft in this country.

I think we have an excellent relationship and there is a great deal of the technologies that we are pursuing that I make reference to in that testimony have a relationship and are of interest and are being worked closely with our counterparts in the military establishment.

Mr. **Brown**. Well, I sense that the problem isn't at the working level. It probably isn't at the laboratory level, but the thrust of a lot of the questioning here this morning has been whether at the policy level there has been the integration that we probably need, or the higher policy level.

Thank you very much.

Mr. **MacKay**. Mr. Griffin, it sounds very much as if you are now out of the advanced—I should have put it—research in space business and in the management efficiency business. Is that what NASA is supposed to be doing? It sounds like we just heard somebody explaining how we could get a Greyhound bus cost down.

Mr. **Griffin**. Well, there is certainly an element. I think it pervades most of Government management today to try to do things as cost efficiently as we can, and we are certainly not immune to that and are trying to get the cost down on everything that we do.

I think it is a little bit oversimplistic to call the shuttle a Greyhound bus. It is a very complex flying machine that requires, I think, probably some of the best technological talent we have in the country.

Mr. **MacKay**. I apologize; it is a flying bus.

Mr. **Griffin**. Sometimes I call it almost something like that in a speech and I cringe every time I do it, but it is a little bit oversimplistic, and we do have, I think, a role as good shepherd of the taxpayers' dollars who have invested a great deal of money in this system to make sure that we do take those steps, as long as our charter is to do that, those steps to make——

Mr. **MacKay**. I agree, and I don't mean to be critical of the fact that one of your research projects is research into better management incentives between the public and the private sector which is an area that is long overdue.

Mr. **Griffin**. I should add, though, I think all of us now, and this includes the Kennedy launch center as well as the major development centers and the research centers in NASA, we have our hands full now with a new program that the Congress has looked favorably upon, I believe, in the space station, and we have a lot to do to make this infrastructure now come to fruition that we have worked on literally for 25 years in this country, and the payoff is almost here. We can't stall out now. At least, that is my opinion. To do so would turn our back on 25 years of very hard and successful work. So, I think we are on the right track. We are trying to get the shuttle costs down, trying to manage that more efficiently, so we can, within essentially the same number of manpower resources within the agency, bring on a brand new capability like space station as well as a number of other smaller projects that make the whole infrastructure work.

Mr. **MacKay**. This is my last question, Mr. Chairman, as far as you know, your space station program is the only one this country is committed to?

Mr. **Griffin**. As far as I know.

Mr. **Volkmer**. The gentleman from Virginia.

Mr. **Bateman**. Mr. Chairman, in light of beepers and buzzers, I am going to withhold any questions at this point, only to add, by way of comment, that I, for one, am very pleased at the response that I just heard from Dr. Hearth with regard to the ongoing cooperative, fruitful working relationship that exists between the research arm of NASA and the Department of Defense. In my view, it is undefensible for that not to be the operating relationship, and if there are problems at certain levels in or near the city of Washington, then I think the Congress in its oversight responsibilities needs to address them at that level. It is encouraging to hear that at the more operative level where the work really gets done that there is a keen insight and a well-developed working relationship that serves the Nation's interest.

Thank you.

Mr. **Volkmer**. The gentleman from Florida.

Mr. **Nelson**. Thank you, Mr. Chairman.

Mr. Smith, what about the cargo processing contract?

Mr. **Smith**. The cargo processing contract was the third area of consolidation we were considering at Kennedy. We are in the final throes of wrapping up what we think we should do there and carrying that to headquarters to Mr. Beggs for his concurrence. There are some gains to be made through a cargo processing contract. We do not have the number of contractors involved in that area that we had in shuttle or the base operating contract. Therefore, the incentives, cost savings, is substantially less than we had in the two previous areas. From that standpoint, it is not an absolute clear-cut decision should you proceed with one of those. We know we have a lot of industry interested in that, quite a few companies that have never done business at Kennedy Space Center, Hughes Aircraft Co., for example, were in my office just the other day asking about the cargo processing contract. I am going to push through within our management channels our studies and try to get a decision on that before the year is out.

Mr. **Nelson**. Mr. Chairman, because of the bells, I am going to submit for the record that I would like to address to Mr. Griffin, looking on down the line where the overall NASA concept of Kennedy being the operational center and the flight hardware processing, and as we get into the space station, in the assembly, checkout and launch of those there, and I have heard rumors that there are others that are talking about a big construction of a hardware checkout, and then ship it down and let it be shot from Kennedy and I want to make sure that NASA understands that we are going to be looking over their shoulder about the consolidation of these. If Kennedy is going to be the operational center, let it be the operational center. So, I will submit that.

Mr. **Volkmer**. Well, I plan to continue the hearings even after the vote, because I have quite a few questions I want to ask yet, even though we have to leave now and go vote and there is probably a vote after that vote, or the possibility of a vote after that. So, we will recess now for approximately 15 minutes and then return.

[Recess taken.]

Mr. **Volkmer**. Thank you very much for waiting. We will proceed now.

I would like to ask you one question and any one of you, Mr. Griffin, Mr. Smith, Dr. Lucas, would answer that in view of the previous witness we had here today. The question is what is your assessment of the shuttle's operational capability in meeting Department of Defense mission requirements?

Mr. **Griffin**. Mr. Chairman, from our vantage point, we think we are making good progress in meeting all their requirements. Let me say that I think one of our problems has been the fact that we have been delayed in flying a dedicated DOD mission. We have found ourselves for the last year or so in what I would call kind of a paper battle, which is typical. I have been there before, and we were all there with the STS when we were trying to get it to fly the first time. There is abrasion at those kinds of interfaes when you are not getting there, and the fact that we haven't flown many military satellites yet, or military payloads, I should say, I think is working against us.

I really believe that once we start, once they get comfortable with the fact that the system works and that the system brings a capability to the table that they have not had before, I believe we will see some of this agitation start to subside. If I have a, let me say, a puzzlement in some of the things that have gone on in the last year or so, it is in that I have been surprised that the DOD still looks upon the shuttle as an unmanned vehicle or sorts, that is, it is just a hauler into orbit. Obviously, those of us that have been a part of the development and the operation of it look at it as a much more capable machine. I think, in time, the DOD will get there but as yet they have not taken what I would call very full advantage of what the shuttle brings to the equation.

Again, I think when that happens, I believe we may see a quick acceleration, if you will, of interest in using the shuttle to its fullest extent. From our standpoint, we are meeting their requirements. Sometimes their requirements, as all system requirements do, bounce around a bit. They have a problem with a weight on a payload or they have something they would like to add to a flight. We have those within NASA as well. That is not unique, but we generally by sitting down and working with them can work out a solution that is acceptable to both. That is what we have been doing in our relationship at JSC with the many facets of the DOD that we deal with, that is, the Systems Command, Space Division out in California, the new Space Command at Colorado Springs I would say are excellent. We have a very good relationship with those people. I am satisfied with it.

Mr. VOLKMER. Does anyone else wish to comment? Dr. Lucas. Mr. Smith.

Mr. SMITH. I think from a launch processing standpoint, we have a very good relationship with the Air Force. I agree with Jerry that I think we need to get two or three DOD payloads under our belt. We have not processed a truly classified payload yet, with all the ramifications of security associated with it. We are going to have some learning problems with that, and I think that is a lot of the concern with the Air Force. At the same time, we have good relationships with the counterparts in the Kennedy area and an excellent relationship with the Vandenberg activities. We are supporting the Vandenberg activity with a large amount of people, both out there and with procurements that we are doing for Vandenberg. We know we are going to have to put more resources into that as we approach the first west coast launch, and I think that relationship is quite good right now.

Dr. LUCAS. We, at the Marshall Center, have good relations with the Air Force, very intense relations with the Air Force on the IUS. As a matter of fact, we have a resident office at space division and have intimate contact with them. We are also supporting the Air Force in preparation for the Vandenberg launch. As far as I know, those relations have been very good.

Mr. VOLKMER. Thank you very much.

I would also like to have your views—we have had a recommendation from the NASA advisory panel and past NASA administrators and were discussing earlier this year again with others that shuttle operating personnel and expenses within NASA be fenced, more or less, from other programs. What do you think about that?

Mr. GRIFFIN. Well, Mr. Chairman, let me take a crack at that one first.

As you know, those kinds of policies are made on or near the banks of the Potomac, and we certainly have our——

Mr. VOLKMER. Yes, I would like to have your views.

Mr. GRIFFIN [continuing]. Our opinions of that. I believe that two things come to mind. One, in many respects, we are fenced today, that is, through the budget process and through the way that we have roles and missions assigned to the different centers. We can identify those pieces of NASA fairly easily that are operations oriented or that are development oriented or research oriented. Certainly, we could do some more, and I don't think any of us at least at my center would have a great deal of difficulty with that.

I think what we must guard against, however, is let's don't do anything dumb in that process. When you, particularly, start talking about fencing people, quite often, we have skills, a single person or a half a dozen people, who have multiskills. In that process, they may be working on program X, but if program Y gets in trouble, we can call them to bear on the subject.

I recall back in Saturn, I can't remember which launch, but we had some fin problems on a Saturn booster that we had to call out—that had been built years before—and we called out people that had worked on that program years ago to solve those corrosion problems on those fins, including, I think, calling some people in that had retired. That kind of flexibility has stood NASA well. We have been able to bring to bear whenever we had a problem the experts within the Agency, all the centers involved, to solve the problem.

If fencing were to say that we couldn't do that, I think that is going a step too far. So, we would have to figure out somehow to cross-utilize skills in the Agency. Again, as I alluded to a couple of times, I think that is being good shepherds of the taxpayers' dollars to make as much use as we can of those people.

But I think fencing in general, while it is a matter of degree and a matter of definition, I don't find that overly offensive or even bad.

Mr. VOLKMER. Dr. Lucas, do you wish to comment, or Mr. Smith?

Dr. LUCAS. My comments would probably be—I would not comment differently than Jerry. Marshall is primarily what we call an operations support function and not truly operations, but I do feel strongly, as Jerry has indicated, that it is important for us to be able to use the total NASA resource in matrix fashion when we have a problem. We have had some rather substantial problems along the way in launching shuttles, and none of those have kept us down very long because we had resources that we could pull off of other things and immediately put them to solving the task.

If they were fenced, as I would interpret it, that would not be as easily done.

Mr. VOLKMER. Mr. Smith?

Mr. SMITH. I think I concur with what both Jerry and Bill have said. I think we, at Kennedy, are a little unique in that the majority of our efforts today are dedicated to shuttle, and a much smaller percentage to Atlas-Centaur and the Delta program. But as space station comes along, we are going to have a fair amount of effort into that. We are going to be assuming certain responsibilities from JSC and so forth, so we have to be careful when we talk about the fencing that we don't preclude that matrix capability that we have all enjoyed. That could be, in my opinion, catastrophic, and I have to believe that the problem that people perceive may be one or more perception than reality, because I think we do have it fenced relatively well today. We could make some improvements, but it is not an uncontrolled overlap of development and operations as I think sometimes people perceive.

Dr. HEARTH. Mr. Chairman, I would like to make a comment using our experience at Langley.

Mr. VOLKMER. Yes.

Dr. Hearth. First of all, I think the idea of fencing is ridiculous. That may be too strong a statement to make at a congressional hearing, but I run a research center, and our business is research and technology. In the process of doing that, we operate, using that verb, some very complicated high technology facilities, maybe not quite as complicated and high technology as the shuttle. Now, if we fenced within my center those people who operated those facilities from the rest of the organization, we would be in deep trouble, because we have difficulties and we have to bring in engineering and support talent or technical talent from throughout our organization to deal with those operation facilities.

So, I think that just in an experience like ours, the idea of fencing as a cure-all doesn't make any sense to me.

Mr. Griffin. If I could add to that, Mr. Chairman, I don't disagree with what Don said. That is why I say it is a matter of definition as to what the fence is and what barrier it puts up. That is to say that if it is a fencing of dollars, that is much easier to accept than—our NASA heritage and our NASA capability are our people, and that is the part that I find very, very difficult to figure out how to fence and then bring to bear when we need it.

Mr. Volkmer. Thank you.

What would you consider is a most serious constraint presently on the space shuttle launch rate? Mr. Smith, do you want to answer that first? Or Jerry?

Mr. Smith. I think the most serious constraint is having a backlog of payloads ready to go.

Mr. Griffin. Well, I was going to say somewhat of a shortage of upper stages that have given us some problems has caused us to not launch as much as we desired. And we have had some, as you know, in fairness, some problems with the basic shuttle itself, but as Bill said earlier, those have been overcome relatively fast. We have had not quite so fast a solution on some of our upper stage carriers.

So, between that and then the fact that our best laid plans sometimes aren't perfect, I believe that is why we have seen the slowness in buildup. But let's keep in mind that we have flown this system only 11 times. If you look at most flight test programs of aircraft or whatever, we are probably much further along at this stage of flight than any system that has anywhere near the complexity of the system like this. So, I think we are on a good curve. I just hope the public, and I know the Congress has always given us good support, hang in with us and I think we will get this thing going like gangbusters.

Mr. Volkmer. Do any of you see any problems with reaching the flight rate of 20 by 1988 or 24 by 1989 at all?

Dr. Lucas. I don't.

Mr. Griffin. No, I don't either.

Mr. Volkmer. Mr. Smith?

Mr. Smith. Difficulties, but no problems.

Mr. Volkmer. Nothing really insurmountable?

Mr. Smith. No. There are some challenges there, but I think the team will rise to it. That is why I say we need that demand really placed on us to get there, and I think we can do it.

Mr. Griffin. Mr. Chairman, just to further that a little bit, at the Johnson Space Center, for instance, we are already working at a flight rate of about 22 per year, if I recall the number correctly, because we have to start the planning process much earlier than we get down to actually cutting hardware and that sort of thing. So, at least from the, let me say, T minus 2 year or 3 year standpoint, we are already working at a rate much higher than we are actually planning to launch. We have some work to do and we have some more efficiencies to gather so that we can hit the 24 and do all the others things that we have to do as a center, but I think we are going to make it. We are on a good course there.

Mr. Volkmer. Mr. Bateman, did you want to say——

Mr. Bateman. Yes, if the chairman would yield for a moment, I see figures this morning of as many as 24 launches a year. Do you feel that that is a realistic target in terms of the present and projected demand for carrying of payloads? What is the trend line? Is the demand curve rising or is it rising at the rate that it was needed or when someone determined that we ought to move to 24?

Mr. Griffin. Yes, sir. I think my answer to that would be that I am confident that by the late 1980's, we are going to need at least a 24 flight rate ability. If you look at it in any one day, it is a little bit like the stock market and you can predict it will be a little bit either up or down. We have seen some down trend for various reasons that if you took the very narrow view you might say there is a problem. If you take a step back, though, and if you look at what people are planning today, and you look at what people have actually got in development today to fly that require the shuttle, we have the traffic to support them.

Mr. Bateman. I take it, then, that there is a pretty good communication network between those of you at NASA who are involved in the space shuttle and the users and potential users who are making their plans that anticipate ultimately the need for putting their payload on the shuttle.

Mr. Griffin. Yes, sir. As a matter of fact, I think between our three centers, and I don't know about Don's center, but between our three centers under the Office of Space Flight, we all are associated in one way or another with future customers, and that association is growing. As a matter of fact, we are putting much more effort into that at the Johnson Space Center. I know from a whole range of science and applications users, Bill Lucas and his people are involved as well as Spacelab, et cetera. Of course, Dick is at the end of the line; he sees them all. So, he has to deal with all of them starting quite early in the process. So, yes, we have our antennae out. We listen carefully. We are learning more all the time about how to deal with them and satisfy them.

Perhaps this is a good time to interject that one of the things that I think that led me to my comment earlier about getting it on and getting to fly with the Air Force, we have found that once we fly a customer, and some of them have come into this thing somewhat awed by the size of NASA and its heritage, et cetera, and they have been scared to death, and even when they weren't really up to speed about what it was going to take to get on, they were, I think, a little bit turned off by it. Once they fly with us, however, we find that they are very satisfied. That, I think, is true with every customer we have flown which I think is a good trend. We are not going to let down and stand on our laurels, but I think that is a good trend and it is one that we watch very carefully. We actually go through with each of them and debrief them at the end of the flight. What did we do, what could we do better? We actually send them questionnaires and talk to them face to face.

So, I think are making good progress on the customer front.

Mr. **Bateman**. Thank you, Mr. Chairman.

Mr. **Volkmer**. I would like to address the problem—or not necessarily the problem—but where we are on the. question of the spare parts and logistics and where we are going with that whole thing, because to me that gets to be part of that turnaround time to be able to make those repairs and replacement of parts and the satisfaction that the part is what it is and doesn't have to be retested and everything to make sure it fits or performs as well as it should.

I guess one of the basic questions I would like to know first is something I don't even know: where are all the spare parts right now?

Mr. **Griffin**. Most of them are at Kennedy but some of them are in orbiters that live in Palmdale, Calif., right now, at least, from an orbiter standpoint. I guess all of our contractors must still have some resources that and the original equipment manufacturer. But for the most part, and I want Dick to respond to this, the stock storing issue function is at Kennedy. That is where finally the water hits the wheel, so that is mostly there now. I think you mentioned about 80 percent, Dick?

Mr. **Smith**. Yes. We have 80 percent of the spares we need basically on hand. Some of the more critical spares, like black boxes and so forth, in the early part of the program, we decided consciously that we would use downstream orbiter hardware for that. I guess in the last year and a half we started procuring that, you might say, spare hardware. All that is not on the shelf yet, but it will be there, and it will either be stored at our place or, in some cases, back at the developer, depending upon where is the right place to be. We usually have the critical spares on hand if they are available right now, and that is looking quite well.

Mr. **Volkmer**. Where is the responsibility as to having the information as to the availability of the parts right now? Do you have that or——

Mr. **Smith**. It is in combination primarily with my people and our contractor, Lockheed, but in close cooperation with the developer, Rockwell or Rocketdyne and so forth.

Mr. **Volkmer**. Who has the responsibility to know?

Mr. **Smith**. The developer today.

Mr. **Volkmer**. The developer does? If you wanted to know if you have a part when something malfunctions on the shuttle or——

Mr. **Smith**. I say that from this standpoint, Mr. Chairman, the responsibility for the spares for the flight hardware today still resides with the development center and their contractor. So, from the total logistics of that, that is still their responsibility. We both, the developer and our contractors, have access to that information, but he is responsible for that information today. That has not been transferred to Kennedy at this point.

Mr. **Griffin**. I was going to make the point, Mr. Chairman, also it is important to understand, I think, two or maybe three factors. One is, as far as the orbiter is concerned, we are still in a manufacturing phase with 104. In order to support that manufacturing capability, the developer must have a capability to control assets in order to build that vehicle. That was true throughout the entire orbiter program. Obviously, when that production line is finished, changes in logistical procedures are in order. In my testimony, I think I alluded to the fact that we are looking at three levels of repair, one going clear back to the original equipment manufacturer and the other just taking place at Kennedy.

As in any large system that I have ever been associated with or aware of, logistics sometimes tends to get shoved a little bit into the future as you have development problems during the development phase. That was no different with shuttle. There were some tradeoffs made in order to overcome developmental problems that were later than a perfect setting in getting our spares laid in and getting the system to underpin that pulled together. However, and somebody correct me if my number is wrong, I think in the 1985 budget of the Johnson Space Center for STS Ops, that one-sixth of our budget, roughly, is going to spares. So, we are in a process, and I will correct that number for the record if it is wrong, we are in the process of rapidly now building our capability to underpin this logistical system with spares on the orbiter.

Bill, you might want to comment on the spares.

Dr. **Lucas**. Yes. Our spares situation is probably a little different because we will have a continuing line, and we have been sparing the external tank and the SRB off the line. I guess the biggest problem we have on spares is on the space shuttle main engine. We, of course, are striving to have a spare engine available down at KSC for each orbiter, and we expect to be there within a couple of years, 1986. We have one down there now and one on the way, I believe.

The other problem on the spares is on the pumps. We are very tight on that and will not be comfortable until we get this phase II program complete and certified as I had testified earlier.

Mr. **Smith**. I think Mr. Utsman had something he wanted to add about spares.

Mr. **Utsman**. You still might have a puzzled look there. We have the two systems. One is called the LIM system, logistics inventory management system. I am speaking of the orbiter. What it does is it tracks both spare parts and those production assets that might be consumed as spare parts. So long as you have a production activity going, those become intermingled. When they move to the Cape and are pure spares, we have them in a computerized inventory system. So, what our people do is jointly and in conjunction view both systems and the agreement is that as the orbiter goes out of production, we would transfer the assets and use just the SIM system for tracking.

Mr. **Volkmer**. In other words, when you are saying by 1986, by 1986 you will be starting more into a true spare parts program.

Mr. **Utsman**. I think what we call the provisioning for some of the late hardware will be done within about 8 months so that all of the review of the parts which we participate from Kennedy with the development center will have been done and the orders placed so we expect the shelves to be filled other than for errors that are going to be natural human errors and guessing wrong on how many parts are necessary. We look to 1986 to be there.

Mr. **Volkmer**. Except if we go ahead next year and start on the fifth orbiter. That is going to throw you all caddywompus again, as we say. Right?

Mr. **Utsman**. I think that again with the inventory levels, as Jerry has indicated, in the budget, we would have the shelf there and we wouldn't be really robbing the production facilities. It is both inefficient from the production standpoint and the operations to run that way, and I think it was prudent to get the experience to make that judgment on how many you need, but now that we have reached that, I don't see that we have that same problem, even with the fifth orbiter.

Mr. **Volkmer**. OK. Fine.

Dr. Lucas, we had testimony yesterday, and I hope when you say 1986 you mean the first part of 1986, because we had testimony yesterday that they thought they would have the spare engine for each shuttle, all four, by the end of December 1985. So, I hope you mean, when you said 1986, you mean January or February so we don't get too far apart.

Dr. **Lucas**. Yes, sir. Undoubtedly, that is what I meant. [Laughter.]

Mr. **Volkmer**. Do you see any problems in developing more reliability for the pumps?

Dr. **Lucas**. We are very encouraged with the progress that we have made so far. Based upon our analysis and based upon the testing that has been done so far, we are very much encouraged and believe we will be able to get there. We are building hardware presently. We will go into the certification test early in 1985 and expect to complete during the year. So, I would have to say that we always are likely to confront problems when you are stretching the technology quite as much as we are here, but we are encouraged, and in our best judgment, we will have that situation in hand in about 18 months.

Mr. **Volkmer**. All right.

Now, you all know that the DOD and reduction we are looking forward to in 1988, 1989, 1990, through 1993, a 2-year—some of us view that as a possibility of seeing reduction in the total number of payloads we may need. That gets down to this question, how sensitive, in other words, how much elasticity is there in these additive costs to a shuttle flight when you reduce the number of flights per year? Any idea on that at all?

Mr. **Griffin**. Well, again——

Mr. **Volkmer**. In other words, we have so much cost per flight and we are going to try to go to full cost come that same time period, 1988 and 1989, and if we start seeing now DOD is going to start pulling out and we are only going to end up with 18 or 19, it is going to cost more per flight and for the commercial people than it would if we were still running with their flights and running 24. We all recognize that. My question is how sensitive is it, that number of flights, as to the cost?

Mr. GRIFFIN. If you went to a full average cost as a basis for pricing, obviously, if you drop two flights out of the equation, you have two twenty-fourths or one-twelfth problem. At least at the Johnson Space Center, we have been working awfully hard to try to get the costs down. We have fed a lot of data to the folks here in Washington that are wrestling with this policy right now. We are trying to determine what that policy is.

I think a lot of it depends on how we finally define the full cost recovery and how we set up for the long term to manage the shuttle system. We could, under some different policies that I have heard of, make it fairly insensitive to a flight dropping off if their prices were more of an incremental nature above some base. Again, that is a little out of my bailiwick, but I think the agency is going to have to, or the Government, in fact, is going to have to come to grips with that pretty quickly here so that we can define that post-1988 policy. We have to have something, and it seems that in any pricing policy, I can think of one or two things that are important. One is the price has to have some stability to it so that the customers know what to plan on. Two, it has to have a stable feedback, if you will, with puts and takes to what the NASA budget process is or the Federal Governmental process is, because it tends to get out of phase very quickly if a flight drops off very late, and oops, you don't have enough cost in the budget to cover the fixed portion of it.

So, that is a sticky one, and I think obviously that decision is going to be made here at headquarters. I hope it is done in a way that it brings stability and calmness to the situation. I guess that is my strongest feeling.

Dr. LUCAS. Mr. Chairman, since I am responsible for a good bit of the expendable hardware, perhaps I could comment on that.

We do have, in the kind of hardware that we produce for the solid rocket boosters and the external tank, variable cost and fixed cost. The ratio between those, of course, is determined by a given situation. It is not the same in the SRB as it is in the external tank.

Now, the variable costs can be controlled if you know it far enough in advance, but the problem is that if we have a late cancellation or we decide this year we don't need a flight, we have already bought that thing. Not only can we not control the fixed cost, we can't control the variable cost very well either. So, the swing from dropping off a mission or two missions doesn't—we just can't save those costs. We have made that investment anyway.

So, if you had a situation where you know well in advance that you are going to have to build a production base and you could drop it off by a substantial amount, then you could reduce not only the variable cost but the fixed cost. But you cannot plan a mission for 3 or 4 years and have it going up and down every year and still do the best job of managing your costs. So, it is very important to us I think.

That was one of the reasons that I was so concerned that if we need an expendable launch vehicle that we use the building blocks out of the production that we now have to minimize the impact of changing mission models on the total cost.

Mr. VOLKMER. In other words, as far as your line, if we are building off on—in other words, a shuttle-derived type of thing, we would still be utilizing the same basic fixed cost right along with it.

Dr. LUCAS. We would be using the same fixed cost. We would be using, to a large extent, the same hardware coming off the same line, and would then minimize the cost impact to the shuttle.

Mr. SMITH. From a Kennedy standpoint, most of our costs are manpower costs. Propellants and things like that really are a small percentage of our cost per flight.

We are in the process, of course, of building up from today's launch rate to 20 per year and hoping to keep the manpower basically the same. So, short-term fluctuations and the drop in launch rate, we would not be able to pull that manpower off of the program; and, therefore, the fixed cost would remain about the same. We think to really get it down, if you are going from say a 20-per-year rate at KSC let's say down to a 15-per-year rate, it would probably take 1½ or 2 years to do that, so it is a long-term proposition. The last thing you want to do is go with rapid perturbations of your work force and create a morale problem that could really be catastrophic to us.

Mr. VOLKMER. Do any of you wish to comment on the need for a fifth orbiter? I will put it on a voluntary basis. [Laughter.]

Mr. GRIFFIN. Well, at great fear of saying something wrong, I will try it anyway.

I think those of us in the implementing side of this business, Mr. Chairman, would all agree that a fifth orbiter would certainly be a nice thing to have. Now, the problem in trying to sit down and justify it on a rivet-by-rivet basis and a payload-by-payload basis is extremely difficult to do. However, I think we have seen enough, and we are probably going to see some more, that we are all anxious to have a robust shuttle fleet. Now, there is no doubt, I believe we can probably hack it with four if you just start looking at numbers, but there is not much margin in that process. It is a little bit like a family with four or five kids, you can get by with one car or two, but it would work a lot easier with three and you don't have to schedule quite so tightly and you don't have to do some things sometimes in a way that are constricting. From that standpoint, it would certainly be a nice thing from the implementing side of this business to have. We understand, having said that, that there are issues which are—it is a matter of priority in terms of our entire space infrastructure. We have to—and that is certainly something that the Congress has to deal with as well as the Executive, and it is not an easy question to answer, and I hope I said the right thing.

Mr. VOLKMER. The other thing, and I know, Jerry, you addressed it in your statement to some degree, that when we are looking at reducing turnaround times, we have still to maintain quality and safety along with it. As we progress in the reduction of turnaround times and we progress, Dr. Lucas, in being able to produce more and more of the tanks and refurbish faster and do those things, what do we have built in to ensure that quality and safety remain? The same way as taking a part off a shelf and sticking it on. How do we know that it is going to work? What are we doing to make sure that we still have quality and safety?

Mr. GRIFFIN. Shall I start?

Mr. VOLKMER. Anybody.

Mr. GRIFFIN. Mr. Chairman, I know you know this but let me say it for the record anyway, there is none of us sitting at this table, nor the people we represent, would ever take any shortcut and accept anything less than a flight being ready to launch. We go through a very exhaustive process of flight readiness, as you know. While we think there are probably some efficiencies we can gather in that, I don't see that changing. We will all sit eyeball to eyeball with us and our key people, and we will decide that the flight is ready to go. You underpin that with literally a constant vigilance. Some systems are somewhat, let me say, for want of a better word, automatic, but primarily it is people. We have to keep our people on the alert and provide them with the right kind of systems and again the management support and underpinning that they can continue to make the kind of judgments we have made for the last 20 years in this business, and it has stood us in pretty good stead.

Now, I don't mean to say that we always have to do things the way we do them today, and we, indeed, are not. In fact, our flight readiness process, both our quality assurance, our safety, et cetera, has become much easier for us. But the vigilance and the amount of what I would call management effort as well as technical effort has not decreased. It has just taken a slightly different form.

I guess, to answer your question specifically, how are we going to make sure it works, you are going to have to and you have, the American public has, entrusted us in NASA to do that, and we are going to have to continue to live up to that trust.

Mr. VOLKMER. Does anybody else wish to comment?

Dr. LUCAS. Yes. I would comment in the same vein that we certainly are not going to compromise our requirements for quality and safety. We will take whatever we have to for not launching on time if we think we are not ready. We just aren't going to do that. So, we are not compromising with our requirements. We are learning what those requirements should be and maybe we have changed some requirements along the way, but none of them that, in our judgment, would compromise safety of flight.

We do have a very rigorous inspection. I testified that we have had two occasions already on the Marshall hardware of the quality readiness reviews where we spend several months in reviewing not only the primes but their suppliers and subcontractors and then we come together with the key executives of those companies for a full day's meeting and kind of check each person's scorecard to see how each company has done in an open, frank environment where all of us are dedicated to the same end, and that is quality hardware. We expect to continue that and do that on 2-year centers.

Finally, we have in our incentive contracting incentivized quality through imposing a very substantial penalty for any defects in hardware that are discovered after delivery or penalties for failures of hardware. I believe the penalties are sufficient in those incentive contracts, I know they are sufficient, to get the attention of the company making the delivery. I believe they are dedicated to the same degree that we are to quality hardware.

Mr. SMITH. You know, I have heard people in the past be concerned about launch fever, that people push to launch. I have been at the center now 5 years. Of course, I came from Bill's center. I have yet to find anything that I would think smells of that term "launch fever." There is a finality of when you commit that vehicle to launch, everybody realizes that you have paid your nickle. You better be ready. And no one that I have ever found wants to cut any corners, if they are not sure it is ready.

The other culture that, I think, is true throughout the Agency and our contractors, and is something we must strive for, is the way you get in trouble in NASA is keeping a problem submerged and not bringing it out where people can take a look at it. You never get in trouble because you have a problem or are concerned about something. You do just the opposite if you keep it suppressed. So, everybody is open to bring out their concerns. The closest thing to launch fever, I would say, is people sometimes get too conservative and bring out problems we put to bed 5 years ago, and get a little nervous, but never pushing to take a risk on the thing. We have to continue to keep that environment, and I think we can do that.

Mr. Volkmer. All right.

Mr. Smith, what do you see as the possible major problem in reaching the turnaround times you are going to have to have to do 20 at Kennedy per year, assuming that you already had all the physical facilities, the additional launch pad, the refurbishment facilities for the SRB's, and assembly facilities and everything else? You have all of that, let's say, by 1989. What do you see as the biggest problem that is going to be there to reach that turnaround time?

Mr. Smith. I think the biggest problem is going to be involving our management techniques, work control, and so forth to meet that launch rate and that demand. I wasn't being facetious when I say the biggest thing we need is the payloads there. The demand is always the greatest motivator of all, and innovator to create that environment. I am continually surprised at what the launch team can do with a problem we run into and we find ways we work that parallel with something else and make up time and not slip a launch date. The first reaction is, well, that is going to take 5 days of launch time. First thing you know, we have brought that around and worked that thing parallel and it doesn't cost us any serial time.

It is the constant working of every little detail to strip out any fat in the schedule. No one, two, or three big things are going to happen. It is just the diligence working at that, and the biggest motivator is going to be the demand. I think we can get there.

Mr. Volkmer. No problem you see in integrating payloads and working up the software, Jerry, and all that stuff? None of that?

Mr. Griffin. Well, I wouldn't say it was without problems, but we have a very flexible vehicle. That is good news and bad news. The good news is that it is flexible and we can do a lot with it. The bad news is that if you make a change, this system is basically computer driven. It is a fly by wire, if you will. The software is essentially the ship's wiring in many respects. So, when we have a late change, and I should add that when we designed this vehicle, somebody mentioned earlier that one of the most important aspects is weight—I think it was Don Hearth looking to the future—we designed this system not to haul a bunch of extra structure into orbit.

In that respect, we have to shape the trajectory carefully to get it out of the atmosphere. That is a very dynamic period. We do that with software.

So, if we change a launch late and we want to go to a different orbit or we want to put different payloads in the cargo bay, much like we are doing right now between 41-D and F, we have to go back and redo that software and that is good news because we have the flexibility to do it. The bad news is that that is somewhat intensive work to do. It has to be verified very carefully, checked to make sure it is right. The consequences of an error could be fatal. As a result, it takes us a while.

However, quite often you hear productivity spoken of more in the flight hardware area, and you hear that from Marshall, who I think has done an outstanding job in their productivity in the manufacturing processes. We are in the same process at Johnson with our software turnaround. We have a production line, but it produces bits on a tape and it produces paper and that sort of thing, so you don't see these big external tanks and solid rockets coming out the end of the door. But for sure it is a production line, and we are adding productivity improvements in there and we are getting this turnaround time down to where, I think without any problem, we will be able to support the 24-flight rate per year. As I said in my testimony, we even have to go to an apparent rate a little higher than that because we aren't going to be flying on the 1st and the 15th of every month. We are going to have some narrow gaps and some wider ones. Yes, I think we are again on a good course.

Mr. **Volkmer**. The gentleman from Virginia.

Mr. **Bateman**. Thank you, Mr. Chairman.

I would like to return to the testimony with regard to shuttle II. What I have heard seems rather sound in the context of a management policy kind of relationship in that it appears that moving forward with this gives you the opportunity or gives the decisionmakers the opportunity to make a steady degree of progress, sophistication, some of which can be perhaps worked into the existing shuttle through upgrade and retrofit until you move to a point where the cost benefits, the demand for service, the economies of a new system then justify going ahead with a totally new system. As you conceive it, Dr. Hearth, do you think it has that flexibility for the decisionmakers as to when to go ahead full bore toward the actual development and utilization of a new generation?

Dr. **Hearth**. Mr. Bateman, I think it is critical that the Nation invest some reasonable amount of resources into advanced technology for a space transportation system to accomplish the very thing you just described. As I indicated in my remarks, the development of a shuttle would not have been possible without an investment made 10 years or so before that, on things like lifting body technology. That was done at Langley, and work at Marshall, and elsewhere, to provide some understanding of the technology and the capability to undertake a development program.

I think that there are things going on today that will probably be introduced in the current shuttle, such as carbon-carbon material for, let's say, the body flap, for example, or some aerodynamic things that we are working on that might be incorporated into the shuttle maybe within 10 years. So, that kind of an investment is a good investment, and it provides the basis of making a sensible decision. That is what we really are in business for, we, at Langley, and other places like ours.

Mr. **Bateman**. As I conceive it, it does lend itself to the expansion of your technology base over time and with whatever concentration of effort can be afforded and the demands on the space transportation system call for, much of which can be in a more immediate timeframe incorporated into, by upgrade or retrofit, in an existing system until your technology is in place for the more dramatic and radical, or not radical, but a higher level of progression to where you then have a new generation.

Dr. **Hearth**. I think the experience in the development of aviation in this country clearly illustrates that point, and the analogy is a valid analogy.

Mr. **Bateman**. What can you offer me by way of comments—you gentlemen on the panel—as to what direction or what should be the underlying philosphy of pricing policies on the shuttle? What are we looking for here in terms of the ultimate best interest of the body politic? Are we trying to maximize recovery of cost? Are we trying to hold down the cost to the user in order that we will be doing more things in space so that that commercialization and greater activity is going to take place there, and is that a tradeoff that says additional efforts or magnified efforts for cost recovery may be counterproductive? How does it fit in with the subsidized cost of foreign launch vehicles putting payloads in space that might otherwise be in our shuttle? Could you give me your insights on those kinds of questions?

Mr. **Griffin**. Let me start here and see if I can weave a thought that may make some sense.

From my perspective, the STS is, or if not considered, should be considered as an instrument of national policy. The object of a pricing policy, then, it seems to me ought to be to assure that we encourage exploitation of the opportunities which it offers first to this country and second to our allies. It ought to—I think—the user who enjoys unique benefits from the use of the system should pay his share of that unique use. Finally, as I said earlier, I think finally to ever market or promote the thing in a way that makes sense, we have to have some stability in that pricing arrangement.

Now, you mix all three of those together and it obviously gets above my paygrade fairly fast. But, I am just hoping that the people who have to make that decision within the executive and the legislative consider at least those three kinds of thoughts. I am not sure that we could put this—if we take the wrong step here, we could put this system on a death spiral where we start to price it out of use and therefore we have fewer flights, et cetera. I believe that is the danger that we have to try to protect against as the national policy is reached.

Again, too, I think that as long as it is a governmental system that there must be some stability on the Government's obligation as well. That is the problem that I have with full average costing or full cost recovery, by some term. If it can be worked out that there is stability provided through the budgetary process that has to underpin the system—in fact—I think it has to be done or the system, whatever pricing policy we come up with, won't be workable for the long haul.

Mr. **Bateman.** Among the other difficult specifics of the equations that you presented, the desirability of stability in pricing normally makes great sense in the marketplace. People don't like to deal with uncertainties of cost, and if they must, they are inclined not to play the game. At the same time, if you are going to have stability in price, it may not accommodate to those considerations of what should a given user pay given the unique economic benefit which they may derive.

Do you see any conflict between the objective of stability of price and the flexibility of price depending upon the nature of the use, the potential, and those economic factors?

Mr. **Griffin.** Yes. I think there is some. There is a dilemma there. On the other hand, if left to be my choice, I would opt to make it as simple as possible so that there is not a varying pay scale depending on how much you think the user is going to derive from it. Mainly, we want to recover, I think, in this day and age, make sure that we recover all the variable costs that we have to expend for a user to use the system over and above what we are doing ourselves.

I think we also have to keep in mind that we are in a competitive environment. That is another piece of this puzzle that you can't ignore. It is not easy to do in governmental systems. On the other hand, many national space—not space but transportation—systems have laid some precedent where we do not try to recover full average cost, if you will, but full cost of whatever unique experience someone derives from it. I realize that is a wordy bunch of thoughts I have given you, but it is a tough issue, and I think could be very pivotal to where this country goes in space. I think it will be this decision.

Mr. **Bateman.** In terms of the competitive situation vis-a-vis expendable launch vehicles vis-a-vis the shuttle, how much of the payload deployed or transported by the shuttle could, if cost considerations didn't enter into the equation, be handled equally as well through the ELV's?

Mr. **Griffin.** The big thing we see now is that on the commercial and governmental side, not so much yet on the military side as I alluded to earlier, we are seeing people beginning to take advantage of the shuttle, its servicing capability, repair capability, such as we did on the Solar Max, that you can't do with an unmanned system, or if you did, theoretically I guess you could automate anything, but it would take you forever and it would be extremely difficult.

Mr. **Bateman.** Could I interrupt at that point? The repair capability, that sort of thing, is there a potential market for shuttle services to repair something put up there by ELV's if that were otherwise a feasible, desirable way, but if something went wrong they could contract with shuttle?

Mr. **Griffin.** As a matter of fact, that is exactly what happened with Solar Max. It was put up by an expendable but with it in mind that it could be serviced by the shuttle later, and indeed it was. We did more servicing than was planned. As a matter of fact, that is why we got into the repair, because we had to unbolt and stick.

Mr. **Bateman**. The fact that, and I am not critical of this, I think it is probably right judgment but it helps illustrate my point, if the shuttle had been made, by policy decision or for whatever reason, unavailable to repair a Solar Max or something else, then I suspect that would dictate judgments in the marketplace as to whether to put it in orbit by an expendable as opposed to having used the shuttle to put it there if it is of its nature something the shuttle could put there. Do we get into some of those kind of policy decisions that have to be made in terms of the development of this very unusual or very exciting transportation system?

Mr. **Griffin**. Undoubtedly. Yes, I think you are right on. You are hitting on the kinds of decisions that a customer must make. As I said, we are beginning to see more people interested in using the unique capabilities that the shuttle brings because it is not just a launch vehicle.

Mr. **Volkmer**. I have one final question. It looks like we have another vote, and I sincerely appreciate your taking your lunch hour to be with us. I would like you to comment, if you wish to.

There has been discussion by some members up here on the possibility in the future, and I am not saying next year or 5 years even, but 10 or 15 years from now when the shuttle is completely operational as the whole system, about spinning it off to a non-NASA, even contractor-type, entity just as we have done at JSC on operations and things. Do any of you wish to comment on that possibility as you view it, the pros and cons of doing that?

Mr. **Griffin**. Well, I don't want to take all this conversation, but I have done a lot of thinking about that.

Mr. **Volkmer**. Fine. Let's pick your thoughts.

Mr. **Griffin**. As you know, we, as you mentioned at Kennedy a number of contracts were consolidated. We are in two consolidations at JSC. At Marshall, there have been a number of contract, let me say, innovations to incentivize the contractors. In that sense, we are and have moved in very much of more involvement by the commercial sector in handling a Government-controlled program. I think that is a proper thing to do, and we are making very good progress, I believe, at having the contractors involved be much more, let me say, nondependent on Government intervention in order to get the job done.

Now, if you consider tranferring—but as I mentioned earlier about quality and safety, NASA is still in the business, and we are still overseeing and managing and controlling the use of the assets that the Nation has put together. It is a complex issue, I think, albeit not impossible if someone made the decision to, but I believe it is a very complex issue to talk about handing it off because it raises some questions that are tough to answer. I am not saying they don't have answers, but I don't have them.

They are questions like what organization should it be handed to. Who has the technical and management skills to pull it all together? That has to be answered, and do it in a way that is at least comparable to the current safety and performance that we operate today. If we transfer NASA people, or NASA facilities to some other organization, is the result that is left over acceptable from a

NASA future development standpoint? Have we wounded it to the degree that it won't be able to function any longer in the way it has?

One of the questions is, this is not the military. We can't hand people orders. Will the staff make a transition, the necessary staff, if we went to another organization? If so, at what price? That is another tough question that would have to be approached. Then you have to look at the incentive structure and what this other organization, particularly if it were a private corporation, you must answer the question, does it bear liability for the loss of the assets as the Government does today? Who is responsible for third party losses? Does the Government subsidize that? Does he pay a royalty for using the assets?

Those are just a few of the questions that come to mind. There are many others and it is complex. It is not easy to answer any of those, and I know that over the next few years, we are going to have to wrestle with each one of those individually and as a collective group to see if that makes sense. I can't give you an easy answer; I don't think there is one. This system was not designed with that eventuality, that likelihood, in mind, so it is a bit of a—I am talking about handing it off to a completely outside the Government organization, so it would take a real close look to see if that is even doable.

Mr. **Volkmer**. Does anyone else wish to comment?

Mr. **Smith**. I agree with Jerry. I think a side comment is if we made a decision that we are handing off the Delta and the Atlas-Centaur. We have proposals from two companies to do that. They are working on their marketing capabilities to see if they can have a viable business. Here is some hardware that the Agency, in essence, was through with. We had no longer our missions for that. It was purely basically commercial business at that time. That is a totally different scenario than where we stand with shuttle today.

We might be asking the question too early. Let's see what happens to that for a while and maybe we can draw some conclusions from it.

Dr. **Lucas**. Mr. Chairman, I believe by the boundaries you have established, it makes the question a lot easier to answer. As I understood it, 10 to 15 years, and I believe if we go out 10 to 15 years with the shuttle that we now are working on and expect to complete the development of shortly, it is almost inevitable that it would be spun off.

If you talk about within 5 years, however, I think it is totally impractical.

Mr. **Volkmer**. No, I am not talking about 5 years. I am talking about over a period of time.

Dr. **Lucas**. I am just bounding my opinion. I think it is totally impractical to do it earlier.

Mr. **Volkmer**. I want to thank all of you, unless, does anybody else have anything you want to add? Dr. Hearth, just to bring that into maybe a little perspective, shuttle II, what would you say would be the earliest timeframe we would have anything envisioned at the present time ready for even a testing phase?

Dr. **Hearth**. Well, as I said earlier, I think that we are maybe 6 to 8 years away from undertaking a development program, something of that order for the type of system I described in that testimony. So that puts us into the 1990 time period. You could begin development perhaps around 1991, 1992, and operational in 2001 or thereabouts.

Mr. **Volkmer.** All right. Twenty-first century. The only thing that I see in that is another little problem, and that little problem is that we have something else already in the development stage that is going to be going on right at that same time.

Dr. **Hearth.** Oh, I am sure of that.

Mr. **Volkmer.** It is called the space station.

Dr. **Hearth.** You asked me when could it be, not when should it be.

Mr. **Volkmer.** And my answer is that you may be pushed back to where the year 2000 is the time you get into it, the development stage, as far as the money constraints, not because you couldn't do it.

Dr. **Hearth.** I understand.

Mr. **Bateman.** May I ask——

Mr. **Volkmer.** Yes.

Mr. **Bateman.** As a very brief followup, are there not some technology transfers that would benefit the second generation shuttle from the work that would be done on the space station?

Dr. **Hearth.** There will certainly be some technologies that we are pursuing today for what I call shuttle II that will be applied to the current shuttle and improvements to that system over the next 10 or 15 years. As far as the space station itself is concerned, I don't believe, I think my answer would be no on that, if I understood the question correctly.

Mr. **Bateman.** As I conceive it, as an inherent part of a space station initiative, there is going to be a transportation logistic factor of getting it and various implements or impediments, whatever you want to call them, and I had thought that in that area, that would enrich the space transportation.

Dr. **Hearth.** Well, I think that as you look out in the farther future, there is no question that as the space station evolves—what we are proceeding on now is the beginning of a really moving into space in a significant way with the space station. And that system will evolve over 10, 20, or 30 years. I am sure it is going to be using advanced space transportation systems, perhaps something like I talked about.

The current situation that we are proceeding on, that these folks and others are proceeding on in NASA, can use the current shuttle. That should not get mixed up on that point.

Dr. **Lucas.** There is another point that I might add, if I may, I think that there is a great possibility of growing the systems that we now have using the building blocks that we have to fill the gap up to the system that Don is talking about, which I think is a must in the year 2000 and beyond, but I think there is a possibility of doing it rather economically if we use the growth versions of these systems that we have now, maybe not every element of that system, but some. You would spread your development over a longer period of time and have more effective costing.

Dr. **Hearth.** I would agree with that.

Mr. **Volkmer**. Maybe we could start on it earlier, too, if we follow that.

Dr. **Lucas**. Yes, sir.

Mr. **Volkmer**. Thank you all very much for being here. You will have to go get some lunch now.

[Whereupon, at 1:45 p.m., the subcommittee recessed, to reconvene subject to the call of the Chair.]

[Answers to written questions for Mr. Griffin, Dr. Lucas, Mr. Smith, and Dr. Hearth follow:]

Responses to Written Questions from the August 1, 1984, hearing at which Mr. Griffin testified.

Question 1:

What does the astronaut training cost? Is this program included in Shuttle pricing?

Answer 1:

Astronaut training is considered in two categories; that training required for the basic operation of the STS and that training mission specific to the user requirements of the particular flight. The basis operation training is not included in the cost basis for the user charge for flights in FY 1986-1988. The actual cost of this basic training is $25 million or approximately 70 percent of the total cost. The remaining 30 percent of the cost is mission specific and included in the user charge cost base.

Question 2:

What percentage of the R&PM manpower budget for JSC is used in support of the STS program? How is the cost allocated to the cost per flight?

Answer 2:

42 percent of the JSC manpower for FY 1985 supports Space Transportation Operations. The cost is allocated based on a spreading function of the average manpower applied over a period of several years.

Question 3:

How are the costs for Shuttle payload processing allocated to the cost of Shuttle operations?

Answer 3:

All of the contractor costs for analytical payload integration at JSC and physical cargo integration at KSC are directly allocated for inclusion in the cost basis of Shuttle operations for user charge consideration.

Question 4:

What is the price of a "Get Away Special"?

Answer 4:

The price of a "Get Away Special" is dependent on weight and volume as designated below:

Maximum Payload Weight Lbs. (kg)	Maximum Payload Volume ft^3 (m^3)	Price for Standard Services
200 (91)	5.0 (0.14)	$10,000
100 (45)	2.5 (0.07)	5,000
60 (27)	2.5 (0.07)	3,000

Since "Get Away Specials" payloads are on a space available basis, these prices are not escalated for inflation.

Question 5:

The Shuttle Utilization Task Force pointed out that NASA suffers from a "success the first time syndrome" that seems to inhibit many small experiments because of the high visibility given failure and because of the high cost of assuring success. What action has JSC taken to address this issue?

Answer 5:

Mission success (non-safety) risk is totally left to the discretion of the experiment developer, and any costs incurred in design and verification to these types of requirements are solely the responsibility of the experiment developer (and his sponsor).

We are well aware that visibility where failures are involved can present problems. That, however, is the nature of our Civil Space Program; and, obviously, to inhibit this open door policy would be detrimental to our national space goals and objectives. To attempt to talk only of successes and suppress mention of failures is not an acceptable method of operation. It is unfortunate that there is a tendency by the media to emphasis failures much more than successes when, in fact, our Civil Space Program history establishes orders of magnitude more successes than failure.

NASA does not control the visibility nor the emphasis placed on failures. Internally, we recognize that anomalies will occur in the small experiment as well as the large system. This in common and normal in any high technology-driven program and especially applicable to this research and experiment world. One fact that we make known is that there is usually a significant gain of knowledge from failures and that

Responses to Written Questions from the August 1, 1984, hearing at which Dr. Lucas testified.

Question 1:

How many missions are each main engine and booster rocket now certified to fly at the 104 percent power level?

Answer 1:

The certification program requires test demonstration on two separate samples. One sample (Engine 210) has completed testing and has demonstrated capability for 20 missions at 104 percent power level. The second sample (Engine 2014) is currently in testing and based on current data has demonstrated 12 mission capability. Testing on 2014 will continue toward the objective of demonstrating 20 mission certification at the 104 percent power level with a planned completion by early 1985.

Question 2:

What does a main engine cost now? What are the projections for the future?

Answer 2:

The current and projected cost of a main engine is $35 million. Current cost is based on engine 2022 which was delivered in June 1984 and projected cost is based on recent contract negotiations for engines 2023 through 2031 which are scheduled for delivery through FY 1986.

Question 3:

What has been the actual experience versus the budget request for the main engine procurement and repair in FY 1982, 1983, and 1984?

Answer 3:

Following is a comparison of actual NOA versus the revised operating plan to Congress for each year. The FY 1984 estimate is a projection based upon the revised FY 1984 operating plan.

	($ in Millions)		Estimate
	FY 1982	FY 1983	FY 1984
Operating Plan	282	367	431
Actual	310	371	443
Delta	+28	+4	+12

Question 4:

What percentage of the R&PM manpower budget for Marshall is used to support the STS program? Is this cost allocated to the cost per flight.

Answer 4:

Fifteen percent of the Marshall Space Flight Center R&PM manpower for FY 1985 supports Space Transportation Operations. This cost is included in the cost per flight.

Question 5:

Are the software development costs for a payload somehow included in the cost per flight? Isn't this a clearly identifiable additive cost?

Answer 5:

The mission specific software and payload integration costs are included in the additive cost data base for shuttle pricing.

Responses to Written Questions from the August 1, 1984, hearing at which Mr. Smith testified.

Question 1:

It is our understanding that the Kennedy Space Center will become the lead center for preparing and integrating payloads for transportation to the Space Station by the Shuttle. On the other hand, we have heard that an alternative "ship-and-shoot" strategy is being considered in which the Goddard Space Center would expand its activities to include complete pre-launch processing for some Space Station payloads. This matter requires careful examination since major processing facilities built at any other center than KSC will not be available to support the Space Station-related activities at KSC. Additionally, if KSC is to continue to provide services to all centers in the form of flight hardware processing, assembly, checkout and launch, the the major payload and Space Station ground processing facilities should be concentrated at KSC. Mr. Smith, what are your views on this matter?

Answer 1:

It is NASA's plan that the Kennedy Space Center (KSC) will be the prime NASA Center for launch and launch support operations for the Space Station. The basic management guidelines for Space Station development, and the concept development effort completed to date, are based upon utilization of the Space Shuttle as the launch vehicle for both initial deployment and logistics operations. In a similar manner, the Western Test Range at Vandenberg Air Force Base will be utilized for polar launches of Space Station platforms.

As you are aware, NASA is just beginning the detailed definition of the Space Station system. The actual operations sequences associated with module check-out, reflight testing, on-orbit assembly, logistics support and other operations will be defined over the next two years, and KSC will participate intimately in these activities to the end of insuring that the KSC capabilities are fully utilized. KSC will be responsible for pre-flight and launch operations, processing of retrieved payloads and logistic support.

The processing facility being considered for the Goddard Space Flight Center (GSFC) is entitled "Spacecraft and Payload Integration/Refurbishment Facility" (SPIRF). This facility would serve a distinctly different function than those provided by KSC facilities. The GSFC facility would be required for long-term development, assembly and check-out of instruments and spacecraft with scientific payloads. KSC's facilities provide for pre-launch preparation of all types of payloads and their subsequent integration and launch.

Construction of the SPIRF would not represent an expansion of GSFC's role, but rather an enhancement of existing facilities which are used for assembly and integration of instruments, spacecraft, and other flight hardware. The SPIRF would provide more clean room space for both assembly and check-out, and the refurbishment of scientific spacecraft and payloads. Construction of the SPIRF at GSFC would not impact KSC's role in Space Station or in pre-launch processing of other large payloads. The type of work which would be accomplished in the SPIRF has never been envisioned for KSC.

Question 2:

What percentage of the R&PM manpower budget for KSC is used to support the STS program? Is this cost allocated to the cost per flight?

Answer 2:

Forty two percent of the KSC R&PM manpower for FY 1985 supports Space Transportation Operations. This cost is included in the cost per flight.

Response to question from the August 1, 1984, hearing at which Dr. Hearth testified.

QUESTION 1:

Has your Center been working with JSC and NASA Headquarters to identify potential uses of the Shuttle for some of the research programs at Langley?

ANSWER 1:

When extension of a research activity into the spaceflight environment may be significantly beneficial to, or required by a research program, Langley works closely with NASA Headquarters and the Johnson Space Center to assure that the Shuttle capability to provide access to the spaceflight environment is fully exploited. The identification of potential opportunities for exploitation of Shuttle capabilities is a continual activity. Use of the Shuttle capability to enhance the research program may take two forms: (1) Use of the orbiter as a carrier for experiments that require access to space and its environment, or (2) Use of the orbiter itself as a research vehicle for the conduct of flight experiments. Current examples of extension of the Langley research program into the spaceflight environment utilizing the Shuttle capability follow.

o On mission 41-D/F, Langley researchers will conduct photogrammetric analysis of the structural dynamics of the large deployable Solar Array.

o On mission 41-G,the Langley experiments MAPS (Measurement of Atmospheric Pollutants from Space) and FILE (Feature Identification and Landmark Extraction) will make their second flight. These experiments use remote sensing technologies to make specific measurements from the space vantage point.

o Also on 41-G, the Langley first of three Earth Radiation Budget Experiments (ERBE) will be launched from the Shuttle on the Earth Radiation Budget Satellite System (ERBSS). This international science program, led by Langley, represents this Nation's most aggressive attempt to understand better the Earth's radiation balance and its impact on climate. The ERBS spacecraft will also carry the second Stratospheric Aerosol and Gas Experiment (SAGE II) developed by Langley. SAGE II will provide a much better understanding of the atmospheric aerosol and ozone variation, and, in particular, the effects of major geophysical events such as volcanic eruptions.

o Three Langley entry research experiments (developed as part of the Orbiter Experiment Program) will make their first flight on the next flight of Columbia. These are: SEADS (Shuttle Entry Air Data System), SUMS (Shuttle Upper Atmosphere Mass Spectrometer), and SILTS (Shuttle Infrared Leeside Temperature Sensing). These experiments utilize the orbiter as a research vehicle to perform entry aerothermodynamic research.

o In early 1985, the Shuttle will retrieve and return to Earth the Long Duration Exposure Facility (LDEF) launched earlier this year--a space first. The 14-foot diameter, 30-foot long LDEF, built in-house at Langley, carries over 70 experiment trays prepared by scientists from a variety of government agencies, universities, industries, and foreign countries. These trays will be returned to the scientists for detailed evaluation of the effects of exposure to the space environment in their own laboratories--an approach only possible using the Shuttle's retrieval and return capability.

o Later in 1985 astronauts will enter the Shuttle's cargo bay in an extravehicular activity (EVA) mode and conduct the Assembly Concept for Construction of Erectable Space Structures (ACCESS) experiment. The ACCESS is a Langley experiment that is a direct outgrowth of our ground-based program to design and understand structural concepts that can be easily erected in space. The truss beam that is built will be some 50 feet long with 126 structural components. The knowledge gained in this flight promises to provide significant contributions for structural building approaches that can be utilized in the Agency's Space Station Program.

o In the longer term, Langley is developing a Shuttle-borne experiment pallet dedicated to structural dynamics and control experiments. This program called the Space Technology Experiment Platform (STEP) will provide rapid and relatively inexpensive access to space for researchers at Langley, other NASA Centers, and other Government agencies, industry, and universities. In addition, we will continue to develop advanced remote sensing experiments to support our atmospheric sciences program. One such experiment, the Halogen Occultation Experiment (HALOE) is currently being built in-house at Langley. HALOE is scheduled for flight in 1989 on the Upper Atmospheric Research Satellite (UARS).

SPACE SHUTTLE REQUIREMENTS, OPERATIONS, AND FUTURE PLANS

THURSDAY, AUGUST 2, 1984

House of Representatives,
Committee on Science and Technology,
Subcommittee on Space Science and Applications,
Washington, DC.

The subcommittee met, pursuant to call, at 10:05 a.m., in room 2325, Rayburn House Office Building, Hon. Harold L. Volkmer (chairman of the subcommittee) presiding.

Present: Representatives Volkmer, Nelson, Andrews, Brown, MacKay, Lujan, and Bateman.

Mr. **Volkmer**. The Subcommittee on Space Science and Applications will come to order.

Today, the subcommittee concludes 3 days of hearings on space shuttle operations.

We have held these hearings with the intent of addressing, in a constructive manner, the operational, management, and policy issues associated with the program. How these issues are resolved will have a profound impact on the return this Nation realizes from the shuttle and on the future of space development.

I have been extremely pleased with the results of our first two hearings and I anticipate that today's hearing will be equally productive. Our focus today will be on operational, safety, and user related concerns associated with the shuttle.

We will begin by hearing from a panel of witnesses representing two NASA advisory groups. On this panel will be William Anders of the NASA Advisory Council and John Stewart of the Aerospace Safety Advisory Panel.

They will be followed by a panel of civilian users that will include John Almond of Telesat Canada, Michael Lyons from Satellite Business Systems, William Ziegler of Western Union, Robert Pace of Microgravity Research Associates, and Gilbert Moore from Morton Thiokol.

We have assembled this panel because of our special concern for making the shuttle as accommodating as possible to the needs of civilian users. It is my hope that what we hear from this panel today will enable us to better assist in moving the shuttle program in directions that will be increasigly user friendly.

Before we proceed with the first panel, let me thank each of you for the contributions that you will make today.

Before recognizing the gentleman from New Mexico, I would like for the record to make a short comment concerning yesterday's hearing and the first witness, Secretary Aldridge. As a result of that hearing, I received a telephone call yesterday afternoon from Under Secretary Aldridge, in which he stated that the RFP was being amended to show that the—RFP for the ELV's, expendable launch vehicles, contemplated by the DOD—launch facilities would not be required as far as specific—but would only be at the Kennedy Space Center. And that he admitted that it was an ambiguity in the RFP, and that was being corrected, and all persons concerned were being notified.

At this point I would like to recognize the ranking Republican member, Congressman Manny Lujan from New Mexico.

Mr. **Lujan**. Thank you, Mr. Chairman.

Last month we heard testimony from OTA that a major problem with the present implementation of U.S. space policy is that there is no national consensus about the long-term goals and objectives in space. Certainly the President's Commission on Space will be a major step in resolving this issue.

But I also hope that this week's hearings will also result in a better definition of what are the policy alternatives for the space transportation system and the respective implications for the U.S. space program.

A crucial policy issue is the relative priorities of the shuttle program. This week we've heard of the need to optimize a variety of different interrelated factors. This—these include the necessity to minimize the cost of shuttle operations; the need for lower prices, the need to minimize schedule delays; the necessity of minimal turnaround times; the necessity of maximum safety; and the need for maximum flexibility; the need for increased flight rates, and the need for quality control.

The present controversy, Mr. Chairman, over the Shuttle versus the ELV's could be compared to the first few years after the introduction of the automobile. For many years the horse remained the dominant form of transportation, even though the auto was obviously the better form of transportation. Imagine what the situation would be today if the Federal Government had insisted that the horse or the automobile were the primary form of transportation. Instead, the country went through a fairly rapid but natural evolution to a new transportation technology.

And today the auto is the dominant form of land transportation. Basically only the Amish still rely on the horse as a primary form of transportation in this country. In my own State of New Mexico, the Navahos no longer use the horse, but instead are totally dependent upon the pickup truck.

I believe that the ELV's will continue to play an important role in space transportation for a period of time, but the shuttle is so clearly the best transportation system that it will soon be dominant.

I believe this will be the inevitable process. We don't need to force it. The important thing for us to do is to assure that national policies don't distort the process.

Thank you very much, Mr. Chairman.

Mr. **Volkmer**. Thank you. And we will begin the hearing with Mr. Anders, and your statement will be made a part of the record in full and you may review it in full or summarize, however you so desire.

STATEMENTS OF WILLIAM A. ANDERS, MEMBER, NASA ADVISORY COUNCIL, ON BEHALF OF DANIEL J. FINK, CHAIRMAN, AND JOHN G. STEWART, MEMBER, AEROSPACE SAFETY ADVISORY PANEL, ON BEHALF OF JOHN C. BRIZENDINE, CHAIRMAN

Mr. ANDERS. Thank you, Mr. Chairman. I would like to make a summary statement and submit my full statement for the record, if that's OK with you.

I am William A. Anders, a member of the NASA Advisory Council and executive vice president of the Textron Corp.

Mr. Chairman and members of the subcommittee:

I appreciate the opportunity to appear before you on behalf of the NASA Advisory Council and its chairman, Mr. Daniel J. Fink. Mr. Fink is not able to appear today because of a longstanding prior commitment, and asked me to present his regrets.

Your schedule that I saw for these hearings listed me as NASA Advisory Council member, and indeed that's true. But also relevant to this hearing, I believe, is my experience as Executive Secretary of the National Aeronautics and Space Council. The NASC was the Cabinet-level forum from which Vice President Johnson formulated his recommendations to President Kennedy on the Apollo program back in the late fifties and sixties. During my time on the Council, from 1969 to 1972, it had lost a bit of its luster and leverage, but did play a role in formulating the so-called post-Apollo program, which was the basis for the continuation of Skylab—which was at issue at those times—and Viking, so forth, and for the initiation of the Space Transportation System development followed by space station; in short, the space program of the seventies, eighties, and nineties, which is basically intact today.

My perspective from the formative years of the early seventies as well as those of my more recent NASA Advisory Council involvement may be of use to you in these hearings.

The NASA Advisory Council is NASA's senior advisory group established to counsel the agency on its policies, programs, and plans. Our recent studies do not cover all the subjects included in your objective statement for these hearings. They have concentrated chiefly on organization, management and policy. Two of the Council's studies completed last year are especially relevant. One, the effective shuttle utilization, was led by NASA Advisory Council member Edgar Cortright. This task force made recommendations in the area of shuttle operations, utilizations, policies, and marketing.

The second study on which I served addressed the mission of NASA and was chaired by Council member George Solomon. One of its principal topics was the examination of options for long-term management of space transportation system operations, and I led the working group that examined the STS management issue.

The reports of both task forces have been submitted to this subcommittee and the mission of NASA report was a main element of Chairman Fink's testimony during your hearings on the Space Act last year.

My written testimony includes a more detailed summary of the recommendations of each of these two studies. In this oral testimony I will simply highlight the scope of each study and then comment on two areas more directly related to this hearing and to my own involvement, that is, shuttle management and pricing policies.

The Cortright Task Force on Effective Shuttle Utilization considered: first, how shuttle operations could be improved to enhance customer appeal; second, what opportunities exist to increase the utilization of the shuttle; third, what changes are needed in NASA policies; and, fourth, how NASA could further strengthen its marketing organization.

The study gave very careful consideration to the views of present and potential customers and their perceptions. That task force made specific recommendations that would: first, simplify payload processing for customers; second, strengthen NASA's support of its own science and technology research because of the intrinsic merit of the research and potential significance for commercial use of space; third, provide policies to take full advantage of current market opportunities and the development of new markets; and, fourth, enhance NASA's marketing organizations.

The Solomon mission of NASA task force considered options for the operation of shuttle ranging from full commercial or quasi-public management to the current NASA approach—then current NASA approach.

The task force recommended an intermediate arrangement placement within NASA but with fenced budget and organization. This organization would have the responsibility for operations as well as for proposing the appropriate next steps, given the development of market and other factors. The task force also recommended that launch-service users be charged only incremental costs of their launch based upon the shuttle's role as a valuable national resource in its conduct of U.S. Government space missions.

From their different perspectives, both task forces commented on two important issues of interest to this hearing: space-launch service management and pricing. I'll focus on the part of the mission of NASA task force study which I led; the first part being shuttle management.

Although the shuttle is not really an operational system in the sense of routine airline operations and will need—and be—a test vehicle for, R&D upgrading as time goes by, our task force believed that there are management steps that should be taken to encourage the pace of reaching a more operational status. A basic driver here is that the NACA-derived, Apollo-structured NASA now phasing down shuttle development and beginning to focus on a space station is basically an R&D and exploratory agency, and resource. It likely does not, nor will not have, the experience and the service-to-customer mindset required for the setup and management of a really efficient operational spaceline. Also, the task force worried that there would be pressures from space station and other R&D and exploration-oriented interests in NASA to divert funds and management attention from the operational issues, and maybe vice versa.

We considered the management options ranging from as is to full commercialization. But the small size of the shuttle fleet, the fact that it still has an R&D role and needs, and its national resource value, suggested a less extreme and more evolutionary move at that time. Hence, the task force recommended that, for the near term, shuttle operational responsibility be maintained within NASA, but that some separation or fencing of management and budget be implemented.

With regard to pricing—in my view the shuttle has made amazing strides toward operational utility in a very short time, but it is hardly in the 707 or the C-130 operational category, as many pricing discussions would suggest. Certainly we should continue to strive to get increased efficiencies and economies in near-term shuttle operations. But we should not kid ourselves, or be disappointed, that the STS as we know it today is more than a first, though important, step in what historians will chronicle as a series of evolutionary developments to provide effective and efficient access to space.

Now, this tends to paint the shuttle as simply the first in a series of reusable, man-driven trucks to and from space—a means to a more important end, that is the increased realization of the benefits of space. But, in addition to this truck role, the task force believes that the shuttle has what we called national value, as a resource for manned space flight, defense missions, space science support, research and technology development in the space environment, satellite retrieval and repair, international activities, and so forth. This view of today's shuttle as both early space transportation and national resource is basic to our task force's pricing recommendations.

It seemed clear to our task force that the cost associated with the national resource value of the shuttle should be borne by the Government and not by the users simply looking for transportation of their equipment to and from space.

Now with regard to the price charged for transportation, history clearly shows that all transportation modes—ship, rail, truck, air—have required and still receive Government support or subsidies to achieve the benefits of the environment they serve. Government support to the construction of 1,000 miles of canals made possible by an extensive network of inland waterways to stimulate commerce. The oceangoing merchant marine has benefited from large subsidies in shipbuilding and purchases, loans, and contracts for mail carrying, to say nothing of the construction of the Panama Canal. The railroads, which linked the United States from coast to coast, received large land grants and were also subsidized for carrying the mail. I need not dwell on the past and present subsidies for highway vehicles.

Most closely related to the Government support of space launch systems is the support received over the years by commercial aviation. This support has included regulatory protection governing fares and market entry and exit, subsidies for carrying the mail, construction support for airports, construction and operation of the Nation's airways, and civil aviation research and development. Even today, with much of the earlier regulation reduced, major support continues through improvement and operation of the airways and with R&D. And this essentially parallels Mr. Lujan's earlier comments.

Why should space transportation be different? Indeed, its size and complexity suggest government support is even more appropriate and important. Therefore, I believe Government support, rather than full cost recovery, is warranted for the development of the shuttle in its space transportation mode.

Further, though I am here to discuss shuttle as a means to achieve increased access to and benefits from space, the increasing importance placed on space access and the benefits clearly require ELV's as backups, at least until shuttle schedule is relatively well established.

ELV's and other prospective launch systems also can offer launch capabilities complementary to the shuttle in meeting unique mission requirements. But, the importance of our major goal—space access and utilization—and the infancy of space transportation modes underscores the importance of taking a long-range view of pricing for the shuttle and its complements. This Nation can afford and should afford to support both.

How the support for the national resource value of the shuttle and the development of space transportation modes should work down to specific prices for launch services was beyond the scope and competence of our task force. But, we did recommend that this important issue be studied by NASA and others, and be guided by our general recommendations.

I would like to close with a brief word about NASA's response to the recommendations of these two studies. On those of the effective shuttle utilization, NASA has reported to the Council that it is implementing many of the recommendations and the remaining ones are under study. NASA's next report is scheduled for the Council's November meeting. On the Council's recommendation that NASA retain a Delta launch capability for the near term, NASA supports the administration policy to commercialize ELV's and stated its intent to meet all future launch service requirements with the shuttle. A NASA response has also provided to the Council on its recommendations in the mission of NASA study. NASA has taken the first steps toward the Council's recommended fencing by separating the shuttle operations budget from its R&D budget, and has further—and has further organizational steps under study. We are satisfied that these steps represent genuine efforts by NASA to be responsive.

As to pricing policies, NASA notes that they are still under study, and we believe our strong policy recommendation on this issue will be given proper consideration by NASA and, of course, hopefully, by the administration and by Congress.

Mr. Chairman, the NASA Advisory Council intends to maintain advisory oversight of NASA's progress in these areas as we do in all of NASA's activities within our purview.

Our upcoming November meeting at the Kennedy Space Center will allow us to get a firsthand view of STS and payload processing and their impact on customers. In addition, we are now examining ways that NASA might facilitate the flight of moderate size scientific experiments on the shuttle. We will examine other STS-related questions as they are requested of us by NASA or are identified by our members or component committees. Our report will be sent to this subcommittee as are all Council reports.

Thank you, Mr. Chairman.

Mr. VOLKMER. Thank you.

[The prepared statement of Mr. Anders follows:]

Statement of

William A. Anders

NASA Advisory Council

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to appear before you on behalf of the NASA Advisory Council and its chairman, Daniel J. Fink. Mr. Fink is not able to appear today because of a long-standing prior commitment and asked me to present his regrets.

As you know the NASA Advisory Council is NASA's senior advisory group established to counsel the Agency on its policies, programs, and plans. The Council's activities are varied; in the past year and a half various panels of the Council have responded to NASA requests to provide counsel on issues ranging from the flight of private citizens on the Shuttle through those of exploration of the solar system to that of the basic mission of NASA for the foreseeable future. Chairman Fink testified before this Subcommittee twice during the first session of this Congress, most recently during your Hearings in October 1983 reviewing the Space Act.

Our recent studies do not cover all of the subjects included in your objective statement for these Hearings. They have concentrated chiefly on organization, management, and policy. Two of the Council's studies completed last year are especially relevant. One, the study of "Effective Shuttle Utilization," was led by NASA Advisory Council Member Edgar M. Cortright. This Task Force made recommendations in the areas of Shuttle operations, utilization, policies, and marketing. The second study, on which I served, addressed the "Mission of NASA," and was chaired by Council Member George Solomon. One of its principal topics was the examination of options for long term management of Space Transportation System (STS) operations and I led the working group that examined the STS management issue.

The reports of both Task Forces have been submitted to this Subcommittee and the "Mission of NASA" report was a main element of Chairman Fink's testimony during your Hearings on the Space Act last year. Because the reports have been provided to and already discussed with you, I will list here only the principal recommendations that bear on the subject of these Hearings and focus the balance of my testimony more directly on my own participation, that is, on Shuttle management and pricing policies.

The Cortright Task Force on "Effective Shuttle Utilization" addressed a set of four questions that must be faced in the relatively near future to help ensure that the U.S. can develop and market the use of the STS in the face of competition from expendable launch vehicles (ELVs), both foreign and domestic. After reviewing Shuttle operations with present users, the Task Force recommended that NASA:

- Continue ELV operations until STS schedule reliability is well established and accepted by the customers.
- Provide for turnover of the ELV inventory by offloading some fraction of ELV compatible payloads from Shuttle to ELVs.
- Adjust the contractual penalty schedule to achieve equity between payload-caused delays and Shuttle-caused delays.
- Improve flexible manifesting at a late date to permit substitution of available payloads on relatively short notice.
- Implement an improved maintenance and spares program.
- Establish a single point program management authority to manage all Launch Services Agreement interfaces, including all Payload Integration Plan annexes.
- Establish standard interfaces for common payload classes, minimizing or eliminating the software interface with Shuttle.
- Critically evaluate the payload processing facilities required at the Kennedy Space Center, and, as necessary, enlarge and upgrade them to support the projected payload traffic, or facilitate implementation of contractor- furnished facilities.

In order to increase the utilization of the Shuttle, the Task Force recommended that:

- Because of the merits of the research, a concerted effort should be made to increase the funding level for space- related R&D at government laboratories where there exists a small, well-defined workload in science, technology, and applications.

- Action should be taken to streamline and simplify the process of getting this class of payload on Shuttle flights.
- NASA, in concert with the DOD, should posture the Shuttle program to support actively the expanding defense space R&D program. The Shuttle should be deemed essential for national defense, with less importance attached to economics.
- NASA should review its organizational structure and resource allocation in support of industrial R&D to assure that this small but important activity is properly nurtured.

Based on their review of NASA's policies governing the use of the Shuttle, the Cortright Task Force made following policy recommendations:

- NASA should offer price and service inducements to stimulate private investment in space R&D and new uses for space transportation.
- NASA should review the postponement policies with a view toward reducing the penalties, and treat any resulting funding shortfall in the same manner as the reflight guarantee.
- NASA should review the discount policy for standby payloads to determine whether there would be takers if the discount were raised, and whether this would be in the best interests of the overall system.
- The Delta ELV should be retained for some time into the future as a NASA launch vehicle complementary to the Shuttle (4 launches per year with 6 backups). The need for other ELVs should continue to be studied.
- A common price should be charged for either a Shuttle flight or a Delta flight, even if a modest increase to the current price is required.
- NASA should give some attention to the formulation of a policy that would give guarantees to space investors of stable service for 15 or more years.
- NASA should go slow on STS privatization.

- A "one-stop-shopping" policy to assist users in dealing with NASA should be adopted--including financing, insurance, etc.

Finally, the Cortright Task Force recommended that NASA improve its marketing of the Shuttle capabilities as follows:

- NASA should strengthen its central marketing organization to deal with the Shuttle customer and Shuttle operations. This should include undertaking a number of marketing-related actions, and establishing policies to provide the necessary marketing tools.
- A position of Deputy Associate Administrator of Space Flight, Shuttle Customer Services, or its equivalent, should be established.
- NASA should select a single private company to assist in the marketing of the Shuttle and to provide contract support to NASA and its customers in the entire interface area.
- NASA should establish a detailed marketing plan with top management review and approval.
- Arianespace financing should continue to be closely tracked to preclude any unfair advantage, which, in turn, might require ExIm Bank response.
- NASA should consider writing, for a fee, some of its own insurance.
- NASA should continue work with the Office of the Special Trade Representative, the Department of Commerce, and the State Department to develop an offset program including a wide variety of goods and services.
- NASA should install a senior customer finance man in the customer support group.

The Solomon "Mission of NASA" Task Force (in which I was involved) looked at options for managing and operating transportation to and from space to the late 1990s and beyond. The report recommended that:

- A new NASA organization should be created at the appropriate time within NASA to focus on Shuttle operations and utilization, including marketing activities and sustaining engineering support. This organization, which should be headed by a Deputy Administrator, should have "fenced" manpower, finances, and facilities.

- The Shuttle Operations organization should continue to enhance customer services and market development activities through the application of resources both internal and external to NASA as appropriate. Consideration should be given to contracting out the market development activities.

- The Deputy Administrator for Shuttle Operations should be charged with proposing the evolutionary steps for future management of Shuttle operations.

- The Shuttle Operations organization should not undertake future STS development activities, such as a follow-on Shuttle or new launch capability. It should, however, help define future requirements for such major improvements.

- The STS should be considered a valuable national resource due to its unique capabilities to provide for manned spaceflight, defense missions, space science support, and research and technology development in the space environment, as well as its special capabilities for satellite retrieval and spacecraft servicing. The total costs associated with this national resource value should not be charged to the Shuttle's launch service users.

- As markets for the STS develop, NASA should consider shifting pricing of Shuttle services towards an incremental (i.e., institutional) cost basis. This is the usual practice in NASA research facilities and, given the national resource character of the Shuttle for civil and military Government programs, is more appropriate than pricing on the basis of total recovery of recurring costs (industrial funding).

From their different perspectives, both Task Forces commented on two important issues of interest to this Hearing, space launch service management and pricing. I'll focus on that part of the "Mission of NASA" Task Force study which I led.

Shuttle Management

Although the Shuttle is not really an operational system in the sense of routine airlines operations and will need (and be a test vehicle for) R&D upgrading as time goes by, our Task Force believed that there are management steps that should be taken to encourage the pace of reaching operational status. A basic driver here is that the NACA-derived, Apollo-structured NASA now phasing down Shuttle development and beginning to focus on a space station is basically an R&D and exploratory agency (and resource) and likely does not nor will not have the experience and the service-to-customer mind set required for the set up and management of a really efficient operational spaceline. Also, the Task Force worried that there would be pressure from space station and other more R&D- and exploration-oriented interests in NASA to divert funds and management attention from the operational issues (and maybe vice versa).

We considered management options ranging from "as is" to full commercialization. But the small size of the Shuttle fleet, the fact that is still has an R&D role (and needs), and its "national resource value," suggested a less extreme and more evolutionary move. Hence, the Task Force recommended that, for the near term, Shuttle operational responsibility be maintained within NASA, but that some separation (or "fencing") of management and budget be implemented.

Pricing

The Shuttle has made amazing strides toward operational utility in a very short time, but it is hardly in the 707 or C-130 operational category, as many pricing discussions would suggest. Certainly we should continue to strive to get increased efficiencies and economies in near-term Shuttle operations. But we should not kid ourselves (or be disappointed) that the STS as we know it today is more than a first (though important) step in what historians will chronicle as a series of evolutionary developments to provide effective and efficient access to space. This tends to paint the Shuttle as simply the first in a series of reusable, man-driven trucks to and from space--a means to a more important end (the increased realization of the benefits of space). But in addition, the Task Force believes that the Shuttle has national value as a resource for manned spaceflight, defense missions, space science support, research and technology development in the space environment, satellite retrieval and repair, and international activities. This view of today's Shuttle as both early space transportation and "national resource" is basic to our Task Force's pricing recommendations.

It seemed clear to our Task Force that the cost associated with the national resource value of the Shuttle should be borne by the government and not by the other users simply looking for transportation of their equipment to and from space.

With regard to the price charged for transportation, history clearly shows that all transportation modes--ship, rail, truck, air--have required and still receive government support (subsidies) to achieve the benefits of the environments they serve. Government support to the construction of thousands of mile of canals made possible an extensive network of inland waterways to stimulate commerce. The ocean-going merchant marine has benefited from large subsidies in shipbuilding and purchases, loans, and contracts for mail carrying, to say nothing of the construction of the Panama Canal. The railroads, which linked the U.S. from coast to coast, received land grants of over 180 million acres in the 22 years from 1850 to 1871, and also were subsidized for carrying the mail. I need not dwell on the subsidies for highway vehicles, ranging from the turnpike companies of the early U.S. to the modern interstate highway system.

Most closely related to the government support of space launch systems is the support received over the years by commercial aviation. This support has included regulatory protection governing fares and market entry and exit, subsidies for carrying mail, construction support for airports, construction and operation of the nation's airways, and civil aviation research and development. Even today, with much of the earlier regulation reduced, major support continues through improvement and operation of the airways and with R & D.

Why should space transportation be different? Indeed, its size and complexity suggest government support is even more appropriate and important! Therefore I believe government support (rather than full cost recovery) is warranted for developing the Shuttle in its space transportation mode. Further, though I am here to discuss Shuttle as a means to achieve increased access to and benefits from space, the increasing importance placed on space access and benefits clearly requires ELVs as backups, at least until Shuttle schedule reliability is well established. ELVs and other prospective launch systems also can offer launch capability complementary to the Shuttle in meeting unique mission requirements. But, the importance of our major goal (space access and utilization) and the infancy of space transportation modes underscores the importance of taking a long-range view of pricing for Shuttle--and its complements. This nation can afford and should support both.

How the supports for the "national resource value" of the Shuttle and the development of the space transportation modes should work down to specific prices for launch service was beyond the scope and competence of our Task Force, but we did recommend that this important issue be studied by NASA and others--guided by our recommendations.

I would like to close with a brief word about NASA's responses to the recommendations of these two studies. On those of the "Effective Shuttle Utilization" study, NASA has reported to the Council that it is implementing many of the recommendations and the remaining ones are under study. NASA's next report is scheduled for the Council's November meeting. On the Council's recommendation that NASA retain a Delta capability for the near term, NASA supports the Administration policy to commercialize ELVs and stated its intent to meet all future launch service requirements with the Shuttle.

A NASA response also has been provided to the Council on its recommendations in the "Mission of NASA" study. NASA has taken the first steps towards the Council's recommended "fencing" by separating the Shuttle operations budget from its R&D budget, and has further organizational steps under study. We are satisfied that these steps represent genuine efforts by NASA to be responsive. As to pricing policies, NASA notes that they are still under study, and we believe our strong policy recommendations on this issue will be given proper consideration by NASA--and hopefully by the Administration and the Congress.

Mr. Chairman, the NASA Advisory Council intends to maintain advisory oversight of NASA's progress in these areas as we do in all NASA activities within our purview. Our November meeting at the Kennedy Space Center will allow us to get a first hand view of STS and payload processing and their impact on customers. In addition, we are now examining ways that NASA might facilitate the flight of moderate size scientific experiments on the Shuttle. We will examine other STS-related questions as they are requested of us by NASA or are identified by our members or component committees. Our reports will be sent to this Subcommittee as are all Council reports.

Thank you, Mr. Chairman.

Mr. Volkmer. Mr. Stewart.

Mr. Stewart. Thank you, Mr. Chairman.

My name is John G. Stewart, and I am a member of the Aerospace Safety Advisory Panel.

Mr. John Brizendine, chairman of the panel, has asked me to appear in his stead as he is out of the country at this time. With me today is Charles Donlan, who was formerly Deputy Associate Administrator for Manned Space Flight at NASA, who is a member of the panel; and Gilbert Roth, who is the panel's staff director.

I might say I guess I have the distinction of being the only nonengineer on the advisory panel, and so it may well be that during our question period it would be appropriate and, indeed, useful for the committee to seek the advice and counsel of Mr. Donlan and Mr. Roth depending on your questions, and with your permission, I would so ask their assistance.

The panel appeared before this subcommittee on February 23, 1984, and presented the results of our activities during calendar year 1983. Our testimony today is based upon that report and the fact-finding activities and discussions we have conducted during the first 7 months of 1984.

Two areas are of particular interest today. One, safety-related issues that the panel believes will face the space transportation system managers and operators as the space shuttle increases its flight rate and improves its operational status. And, two, thoughts on the panel's agenda in the near term and in the future as the space transfer—transportation system matures with routine-type missions. Routine as applied to operational missions must be viewed in light of the inherent sophistication and complexity of both the space shuttle as a carrier and the payloads to be carried.

A jet aircraft can be turned around for another flight in hours. The space shuttle and its payload will require several weeks of work by many, many highly trained personnel. And this situation is going to be true year in and year out as long as the present space transportation system is in use.

In many respects I have thought that the challenge of maintaining this operational discipline over the long term is as difficult a challenge as was the one that faced NASA engineers initially with the research and development that led to the space shuttle. And, of course, this routine operational and maintenance challenge is one that is not as quite as exciting, is not as much in public view, is more difficult to maintain, but it certainly, from a safety point of view, absolutely is essential as the initial concerns that were associated with—with the first four flights, the so-called R&D flights.

I would like to state how the panel views the current and near term period through which the space transportation system is now going—a transition from research and development or early operational to full operational status with launches every 2 or 3 weeks. This evolutionary period contains maturing activities such as the shuttle processing contractor work at the Kennedy Space Center, the upcoming consolidated support contract at the Johnson Space Center, tighter hardware and software change control, operational logistics, and developing operational management systems.

In making the transition to a fully operational status the panel urges that attention be focused on such areas as:

First, planning to assure continuity of the necessary space transportation system expertise at all levels. This would include feeding in of younger personnel. And if one takes a long view of 10 to 15 years, one simply cannot assume that these trained personnel will be present. It's a management and training challenge that NASA and the contractors, and I would hope the Congress, would take very seriously.

Second, management must maintain a thorough understanding and continuous reassessment of operational hazards and risks.

Third, expansion of the mission flight envelope while maintaining adequate structural safety margins.

Fourth, appropriate planning and funding to meet logistic support demands and to assure the adequacy of vital crew training.

Fifth, hardware and software changes and their certification for flight.

We are aware of no issues at this time which should constrain the conduct of currently scheduled missions. However, I would like to mention briefly some safety-related issues of continuing interest to the panel.

First, the maintenance of a high level of product quality throughout the life of the program. This was an issue we touched on in our annual report. I know it is an issue of considerable concern with NASA. NASA is responding with an active and serious program of counseling and motivation with the NASA contractors. But when you look at the small number of items that often are procured for the space transportation system, the high cost of these items of—it is a continuing management problem to be sure that you have adequate sources and that these sources are producing the kind of quality product that must be used at all times for the life of the program.

Second, in the areas of continuing interest to the panel, is the definition of orbiters—the orbiter structural adequacy and required modifications. This is an ongoing effort which I think the panel believes NASA has well in hand, although we have encouraged NASA, if possible, to accelerate the continuing definition of the orbiter structural characteristics.

And, three, steel and composite solid rocket motor case and rocket nozzle adequacy for one or more uses. This is a—particularly as it relates to the filament wound case—this is an important R&D item on the agenda, and key development and qualification testing lie ahead in this area.

Four, spares availability for critical functions within the ground and flight systems, for example, space shuttle main engine turbo machinery and controllers, avionics for the orbiter, and computers for the launch control system.

I know this has been an area of concern to this subcommittee and it is still a matter of concern to the panel that there be adequate amounts of machinery. We all realize that these highly complex devices are produced only with considerable leadtime, that there is money now in the pipeline but we still have to grapple with this problem of cannibalization every time, or often, when a main engine develops problems.

Five, shuttle orbiter payload interfaces with regard to the potential for fire, for violating outer moldlines and the need for extra vehicular activities. And here, of course, the focus will be on the Centaur as it comes into operational use in the coming year.

Six, orbiter approach and landing flight control, that is, landing speed and pitch sensitivity which dictates sustained intensive flight crew training programs.

We had a—the panel had a very interesting conversation with John Young and several of other—of the initial astronauts about the—the challenge of landing the orbiter. Sometime the committee might well want to have a similar conversation. It really—if one thinks back to the old days of the Mercury Program and the need for highly qualified test pilots, where that was somewhat of a question for some folks, I suppose. But there is no question about it now when it comes to landing the orbiter, it is a very demanding, very difficult task which is—which, when you see it on television, looks kind of simple and straightforward. But as John Young would tell you, it is anything but that.

Mr. LUJAN. We wouldn't get a demonstration.

Mr. STEWART. That's right, that's right.

So that is a—that is an area that we will continue to follow.

The panel's continuing shuttle-related role in the years ahead would cover the continuing areas of interest that I've discussed previously; development and certification of component and system improvements, of which there will be many; interfaces and relationships between the space shuttle and the developing space station, including the station payload building blocks.

An area that cannot be defined at this time, but it has become a normal periodical panel function, is our support of special NASA teams dealing with technical and management issues and its participants and observers when failure and accident teams are formed.

The panel expects to follow a number of areas, some of which are upgrading of critical equipment on ground facilities and flight vehicles; the effects of crosswinds on landing and landing sites; abort capabilities; use of extravehicular activity capabilities, including the manned maneuvering unit; launch commit criteria and red lines.

A special area is the system redundancy philosophy and its implementation to assure that failure rates, problem areas, and criticality are factored into system modifications and the logistics program.

The Panel appreciates this opportunity to explore the safety-related facets of the space transportation system now and as expected in the future. The safe and successful STS missions depend upon the attention applied today and the continued focus of everyone from the hands-on workers to the managers at the top level of NASA, to assure quality products and effective and efficient preparation for each launch. Our role will be to help assure that this is the case.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Stewart follows:]

JOHN C. BRIZENDINE

Chairman, Aerospace Safety Advisory Panel

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

Mr. Chairman and Members of the Subcommittee:

(This material presented by Mr. John G. Stewart, Aerospace Safety Advisory Panel member, on behalf of Mr. Brizendine and the Panel.)

The Panel appeared before this subcommittee February 23, 1984 to present its findings, conclusions and recommendations as a result of its fact-finding work during calendar year 1983, as well as the Panel's direction for 1984. This included copies of our annual report. Out testimony today is oriented toward safety-related issues that the Panel believes will face Space Transportation System (STS) managers and operators as the Space Shuttle increase its flight rate and improves its operational status. Additionally, we will express our thoughts on what should be the Panel's Shuttle-related role in near-term and future periods as the STS reaches maturity with "routine" missions.

Before setting down specific observations, we would like to comment on how the Panel views the current and near-term period through which the STS is now going. From our viewpoint the progress is steady and moving through the latter stages from

Research and Development to the period of being fully operational. However, it should be recognized that there are still a number of developmental aspects of the program and that these will continue for some time. Thus it can be expected that variances and adjustments to plans and timetable will be encountered from time to time. It would be a misconception and an unrealistic comparison to expect airline-type routine operations of the Shuttle. Its mission and the means by which the missions are accomplished are orders of magnitude more complex than airline operations and must be approached and executed accordingly. The important consideration is that each mission be carried out safely and successfully. The STS safety record thus far is 100 percent and we on the Panel are pleased to see the system performing as designed to protect that record. This evolutionary period contains many associated maturing activities such as the Shuttle Processing Contractor work at KSC, the upcoming Consolidated Support Contract at JSC, tighter hardware and software change control, updating and/or replacing of critical equipment nearing obsolescence, operational logistics, and so on.

In making the final transition to an operational status the Panel urges that attention should be paid to such areas as:

1. Specific planning to assure continuity of the necessary STS personnel experience and expertise at all technical managerial levels, including the "feeding in" of younger personnel in appropriate measure to match organizational

2. Program continuing activities as well as modifications (hardware, software, ground and flight) must be scrutinized to assure that management maintains a thorough assessment and understanding of operational risks as the STS program becomes more routine.
3. Expanding the ascent and descent flight envelope to meet mission requirements while allowing sufficient structural margins in critical areas such as the Orbiter wing and lower fuselage areas.
4. Appropriate planning and funding for critical support requirements, e.g., those spares critical to meeting operational schedules and to assure that adequacy of vital crew training.
5. Careful assessment when accepting a single event accomplishment as proof of capability of hardware and software for both flight and ground support equipment.

There are a number of safety-related issues that concern the Panel, but there are no issues that we are aware of that preclude conducting safe and successful missions. Some of these safety-related issues dealing with personnel, hardware and software include the following:

1. Maintaining a high level of product quality will remain as a continuing thread throughout the life of the program particularly as the flight rate increases to 12, then 24 and more over the next decade. NASA in their response to the Panel's Annual Report of January 1984

states that: "(NASA) totally supports the Panel's position on the need to emphasize motivation of the Space Transportation design team to yield the highest quality product oriented toward operational suitability. To be effective such an effort must originate with senior management. To emphasize (our) commitment to quality production, (NASA) established the position of Director of Productivity in the Office of Productivity Improvement and Quality Enhancement. (The Adminsitrator has) personally addressed numerous groups and also has prepared a video tape for use by (NASA's) contractors. (NASA) established the NASA Productivity Steering Committee which (the Administrator) chairs and which has Headquarters' Associate Administrator and Center Directors as members." The first meeting was conducted on April 26-27, 1984 with more than 200 persons in attendance. The key has to be the involvement of senior management as well as the mid-level managers in all the critical disciplines, and NASA appears to be doing this by both example and strong encouragement on a continous basis.

2. The Solid Rocket Motor program, the major component of the Solid Rocket Booster System, was recently reviewed by the Panel. This included both the steel case segments and the new filament wound case units, with particular attention to the nozzle subsystem. NASA and its contractor have thoroughly examined and upgraded the

nozzle material and processing, manufacturing and assembly to preclude in so far as practical the problem experienced in STS-8 when a nozzle erosion problem far exceeded expectations. The examination of nozzles on Solid Rocket Boosters used since that time indicate the success of the material and manufacturing upgrade program. Here again, constant attention to the many process and material variables must be rule. The composite structure of the filament wound case has received and continues to receive a great deal of attention by both in-house and external technical groups to assure proper design, adequate testing and handling. The composite-to-steel clevis joint continues to receive additional attention to assure adequate material safety factors. At least a single safe use of these filament wound cases appears likely following successful completion of upcoming full-scale tests.

3. Orbiter structural adequacy was discussed in some detail in the Panel's annual report. This concern originated from the use of structural loads data defined in the 1976-77 period and the weight reduction program initiated soon therafter. A new loads cycle was initiated in October 1983 and is scheduled to be completed by 1987. Since 1982 NASA examines the loads for each flight and defines the trajectory to maintain adequate margins of safety and will continue to do so until the new loads cycle provides updated information.

Additionally, structural beef-ups have been made to those Orbiters currently flying and in OV-104 which will be delivered to the fleet next year. Until the loads on the Orbiter and the full-stack are fully defined the vehicle will not be flown outside a known safe flight regime. The Panel is urging an earlier completion of the latest loads analysis.

4. There has been a great deal of progress made in defining critical spares, repair modes, maintenance of hardware sources and the like. However, the spares situation with regard to the Orbiter and the Space Shuttle Main Engine appears to be quite tight for the near-term. It is an area that will require continued management attention particularly as the new Shuttle Processing Contractor at KSC takes on more and more responsibility. It will also require priority funding.

5. In examinng the upper stages, for example, the Payload Assist Module (PAM), the Inertial Upper Stage (IUS), and the Centaur, as well as the many payloads carried aboard the Orbiter, our reviews concentrated on their interfaces with the Orbiter and Ground Support Equipment. Major reasons for this interest are the potential for accidents involving flammable materials and the violation of the payload bay door moldline during any stage of the mission. All payloads, including upper stages, are required by NASA to be two failure tolerant where a potential exists for such a

hazard. This policy is enforced by special review teams and boards to assure safety of flight. There are cases when waivers are granted after thorough analyses which generally means the possibility of failure is very, very low and crew safety has not been compromised. This will, however, continue to be an area that will require vigilence to maintain the thoroughness as the flight rate increases.

6. The Orbiter brake problems, based on our latest review, are certainly under control. A number of reviews, including that of an outside group of experts, have noted that this is not a safety issue but one of continue operational development. There is a definite need for flight test instrumentation on the gear, brake, and hydraulic system to more clearly define the basic problems to support resolution of them. The Orbiter mid-body structure limits the landing weight capability to about 240,000 pounds.

7. The Panel has discussed approaches to the improvement of the flight controls during landing, that is, pitch control near the ground, to reduce excessive speed and control sensitivity. There does not appear to be any practical way at this time to alter these characteristics without undue impact on the vehicle, crew training, and available resources. NASA has explored the practical problems associated with installing such aero-controls as canards on the Orbiter

and presented its conclusions to the Panel. In summmary, the impact of adding canards to the present design are considered prohibitive compared to the benefits. The current high degree of crew capability will be maintained through continuing intensive training in both ground based and flight units.

As the flight rate increases and the overall Space Transportation System becomes fully operational STS managers and operators will have to contend with some of those items mentioned previously:

- product quality and suitability of the modified and new hardware to meet turnaround and reliability needs
- logistics support including sustaining engineering
- payload interfaces
- continuity of the necessary Space Transportation System experience and expertise at all levels with organizational and personnel changes taking place in the coming years
- launch and landing from Vandenberg Air Force Base
- cross-wind landing capability
- weather forecasting and regular landings at KSC.

The Panel would like to suggest NASA examine the practicality of using an Orbiter as an R&D vehicle in addition to its normal mission activities. The Orbiter itself is the only vehicle capable of negotiating the complete velocity and heating encountered during STS missions. This knowledge would help resolve current problems and point up future technical directions. The high technology information which would become available through its use would also be applicable to advanced commerical and military vehicle design. Our view of what the continuing Shuttle-related role of the Aerospace Safety Advisory Panel should be in the years ahead considers:

1. Continuing areas of concern and issues from the current period of transition from R&D to full operations at both KSC and VAFB.
2. Development and certification of component and system improvements such as the filament wound case for the solid rocket motors and the Space Shuttle Main Engine refinements currently under discussion.
3. The interfaces and relationships between the Space Transportation System and the developing Space Station which includes the payloads to build the Space Station and operations of the Space Station involving the Shuttle.

An area that cannot be defined at this time is the Panel's support of special study ad hoc teams and failure or accident investigation team requirements.

More specifically the Panel expects to follow the upgrading of critical equipment such as the Orbiter general purpose computers, the launch computer systems at KSC, the fuel cells, auxiliary power units, and so on. From a management perspective the Panel expects to assess hardware and software change control (including launch commit criteria and red lines) to see if it is adequate with regard to safety of flight items, and that changes in organization do not compromise understanding of hazards and risk assesment judgments. Shuttle abort capability, the use of extravehicular activity (EVA) modes, and functional redundancy during the operations era are of great interest as the flight rate increases and the increasing need to support the Space Station program. With respect to system redundancy, a review of the redundancy philosophy as well as its implementation is of value to assure that during a long period in which failure rates and problem areas are determined and modifications are made to the basic Space Transportation System that the proper degree of redundancy is maintained with regard to safety and turnaround times.

The Panel appreciates this opportunity to explore with you those Shuttle safety-related areas that are to our minds basic to the continuation of NASA's excellent safety record. The safe and successful utilization of the Space Transportation System now and in the future depends upon the attention of people at every level of the organization, from the hands-on workers on up the ladder, and their continued devotion to the job. The Panel's role will be to help assure this continuous attention.

Mr. **Volkmer**. Thank you, and we will begin the questioning. We will stick today, which we didn't the last 2 days, to the 5-minute rule, and we will begin with the gentleman from Texas. Do you have any questions or do you have to leave right now?

Mr. **Andrews**. No questions.

Mr. **Volkmer**. All right, OK. I'll then recognize the gentleman from New Mexico.

Mr. **Lujan**. Thank you, Mr. Chairman.

Bill, I'll tell that story again since we're talking about safety about being up at the nuclear plant at Dounreay for—Bill, who is an engineer, asked the fellow, well, you know what kind of things have you done to assure the safety of a particular valve. The guy said, well, it hasn't blown up yet. I guess we do a lot better—a lot better than that.

But I agree with you that the shuttle is a national resource, that—and the subsidization of it does not bother me at all. As a matter of fact, some of the things that I would like to ask you about is what we might be able to do to bring industry in with research projects, even to the point of saying, well, if you have a legitimate research project, we are not going to charge you anything for being on the shuttle. You are doing—you are partially doing our work for us.

What's wrong with that concept?

Mr. **Anders**. Well, I think that is a good idea, Mr. Lujan. It—the, as I understand it, NASA, to the degree they can, recognizing they are constrained by executive and legal policy, is doing a good job, in my view, and encouraging industry to become involved.

The fact of the matter is, though, that this early, very early, stage in opening up the environment of space to commercial and other activities—when one considers return on investment, one has to have an awfully large return near at hand to justify the cost involved. Therefore, in my view, like the other modes of transportation opened up the environment of surface transportation, or rail, or sea, we really should consider subsidizing these and other activities in order to get these benefits.

I'm speaking as a businessman and basically free enterprise guy, but I think we have—we have a much narrower focus on this issue than we should have from a national, long-term national value point of view.

Mr. **Lujan**. Part of your comments were that we had to have—we should have a ELV capability. What do you mean? Should NASA keep a few of them around, kind of to in a sense since NASA is so opposed to the Defense Department having their own ELV capability they say is backup?

Mr. **Anders**. We have a dilemma.

Mr. **Lujan**. Should we go into that? Should we go back into the ELV business?

Mr. **Anders**. Well, the NASA Advisory Council and the Cort—the study that I was involved with, and the Cortright study both found that there should be backup capability in this early stage of shuttle development; in my view, much earlier than a lot of conversation these days about operational ability would suggest. Whether that's done by the Air Force, by NASA, commercial activity, or all of the above, is of much less interest to me than the fact that we do have some backup, because the shuttle is an immature system. And as I said in my testimony, I think this country can afford to both—not luxury, but necessity—of supporting the shuttle so that it develops maturity and can lead to even more efficient shuttle-like vehicles, but at the same time have backup for commercial and—and even—and certainly for important DOD missions.

Mr. LUJAN. Are there—what shipments are there that are so critical that they can't wait a couple of months——

Mr. ANDERS. Well.

Mr. LUJAN [continuing]. Until they fix the engine, or bring another one along?

Mr. ANDERS. As I—I read Under Secretary Aldridge's testimony of yesterday, from which—where he addressed this in general. And I would to like to defer for classification and other reasons to let his comments stand on that point. But I—I do think——

Mr. LUJAN. Well, leaving aside the DOD, say some commercial ventures or NASA——

Mr. ANDERS. I know of none in particular, but that's basically because I'm just not that aware of what's going on in that phase of the activity. But I can tell you as a businessman, that if you do have to extend the time when you're under your own investment pressures to get the return on your investment due to launch delays, or whatever, than that hurts. Hence, since—and since delays are, I think, inevitable, and should be not a question of a lot of surprise and gnashing of teeth, but just the realization that we're really at the beginning steps of a reasonable transportation system, that we ought to reduce the price of the launch and, therefore, not make delays so painful.

Mr. LUJAN. There's many of us on this committee that feel that the—that space should be commercialized as soon as possible, that in the final analysis the reason for all of our space program is one, of course, the defense interests of the country; and the second is for the benefit of mankind, and that's how we distribute those benefits is to the commercial system.

You make a point, of course, that the shuttle is still in the R&D stage and so we shouldn't move that quickly. And I agree with you.

Do you think that eventually we move to commercializing even the shuttle?

Mr. ANDERS. Well, our committee did view that in the longer term, and please don't try to pin me down as to how long a longer term is, I will tell you 50 years from now as I look back, if I'm still around.

Mr. LUJAN. I hope it's not that long.

Mr. ANDERS. Well, I think aeronautics would show that that's the kind of time periods we're generally talking about. But that—that certainly using aeronautics and aviation as an analogy, we have important aviation activities that are done specifically for defense issues and done by the Department of Defense. And we have the very important aviation industry that's commercialized. And I would—I would guess and would frankly expect, and be surprised if we didn't see, the same kind of thing happening in the space program. And I'd—I'd just urge everyone I have a chance to talk to, including the President, if I had a chance to talk to him, not to try to push the—the shuttle too fast and expect the ability to become completely efficient and completely replace all launch vehicles. I think it's a one heck of a good first step but only that.

Mr. **Lujan**. Well, as long as we're using the kind of shuttle that we're using today, that probably is not reasonable to expect, that——

Mr. **Anders**. Except the pricing policies suggest that there are some who expect to have this thing operating like the Greyhound Bus line or Eastern Airlines. And I think that's very shortsighted.

Mr. **Lujan**. I think we have to wait for future generations of shuttle.

I think the chairman's getting nervous here so I'd better quit. [Laughter.]

Mr. **Anders**. I wasn't sure whether it was his 5 or your 5 minutes of time, I'm sorry.

Mr. **Volkmer**. The little dinger on the bell on the timer clock didn't go off so your 5 minutes, or 7, I guess about 8 minutes has expired right now.

The gentleman from Virginia.

Mr. **Bateman**. Thank you, Mr. Chairman.

Mr. Anders, I first want to tell you how pleased I am to see the way you've highlighted the recommendations of my friend and neighbor Edgar Cortright's study. There's one element that I have been curious about over the past—well, yesterday's hearing and even before that. I don't have much of a handle on the extent to which a given payload is compatible with being launched on either shuttle or an ELV.

Could you quantify the compatibility factor to any extent? Is 50 percent of all payloads compatible with being deployed by either system, or——

Mr. **Anders**. I would like to be able to give you an answer but quite frankly, that's beyond my area of expertise. I certainly think and share Dr. Cortright's view who is also my friend—and that—the more compatibility one can have, the better.

Mr. **Bateman**. Uh-huh.

Mr. **Anders**. But generally you have to pay a price for that. But I think it's a good design goal and how much it's implemented or will be realized, I am just not competent to say, I'm sorry. We—I could probably get NASA to get an answer for you.

Mr. **Bateman**. Well, Mr. Chairman, I think that is something that the committee would benefit from, if NASA or someone could give us a focus on the extent that there is a compatibility factor as I very loosely understand it and being very untechnical, as you know. There are certain things that you want to put in a certain place that you can only put by one methodology and not the other. But I don't have any feel at all——

Mr. **Anders**. I have——

Mr. **Bateman** [continuing]. For it, 5 percent or 95 percent, don't have——

Mr. **Anders**. I have heard it expressed by users that to the degree they could simply plug in quickly to the shuttle, particularly those who are sort of waiting around to fill in holes in the schedule—and I understand there's quite a few of those—the more quickly they can plug in, why, of course, the more they will be utilized and the less they have to wait for the data.

But I thought—it is my impression that NASA's sensitive to this and is—is trying to do something about it. But I'll ask them to get you an answer on that.

[The information follows:]

Question submitted by Rep. H. Bateman: To what extent are payloads compatible with shuttle and ELV launches?

Answer. I am informed by NASA that, at the present time, the majority of commercial communications satellite payloads are designed for dual (STS and ELV) compatibility. When the Shuttle demonstrates its ability to maintain a reliable launch schedule service, NASA expects the users to develop Shuttle-optimized payloads. Of course, any payloads requiring human attendance on orbit, such as the Continuous Flow Electrophoresis System and certain spacelab experiments, are designed only for shuttle.

Mr. **Bateman**. Well, that helps me focus on in a way what pricing policy should be. Because I would think that if we had done the thing correctly, all other things being equal, if there's a compatibility of using the shuttle or an ELV, we ought to let the user elect the one within their time frame which is realistic that's most economical to the user. That's going to get more things going on, that's going to spread the societal benefits of space activity, if we approach it in that way.

Mr. Chairman, I'm sure my 5 minutes are nearing a close. Let me just say that I think this hearing and the presentation of the witnesses this morning is very helpful in bringing us to a focus on what shuttle operational policy should be, and I certainly concur with the major thrust of the recommendations with respect to those policies I've heard this morning.

Mr. **Volkmer**. I thank the gentleman. The gentleman from Florida.

Mr. **Nelson**. Thank you, Mr. Chairman. Good morning, gentlemen.

Mr. Anders, could you follow up on page 3 where you talk about the Delta ELV should be retained for sometime into the future as a NASA vehicle complimentary to the shuttle—four launches a year with six backups?

Mr. **Anders**. Congressman, again, that is a finding of the Cortright group of which I was not involved. And so specifically why they picked four launches a year, my guess is it's—it's for some—to maintain a reasonable efficiency there. But that is consistent—the specific recommendations of Delta's is consistent with our Task Force, the Fink Task Force's recommendation that there should be some backup ELV capability, at least during the shuttle proving out and development period. So I—I wish I could be a little bit more specific but that's about the best I can do on that point.

Mr. **Nelson**. Mr. Chairman, has anybody mentioned earlier in the comments that gives credence, then, to the Air Force in their wanting to have an additional ELV capability all the way through 1993—1988 to 1993?

[Mr. Volkmer nodding no.]

Mr. **Nelson**. How many years in the future do you see that that backup commercial ELV activity should occur?

Mr. **Anders**. I would really be out of my league to give you an ex—any sort of exact date. But I, frankly, personally—this is not—this is Anders speaking, not Fink Task Force, we didn't look at that in detail. But my guess is it will go on, and probably should go on, for quite some time, because to the degree you see the shuttle as quote, fully operational, unquote, the less you need such a thing; except for this point of having all your eggs, national security eggs, in one basket, which I think is a point worth listening to.

To the degree you see the shuttle as sort of a beginning step, more R&D oriented than has been stated heavily today, my guess is the backup would probably be—be well worth maintaining. And, again, it's something I think this country can't afford. If you put pressure, heavy pressure, on NASA to become quite cost effective, that then relates—becomes a function—their ability to do that becomes a function of their mission load, anything that takes away from that cuts the denominator out of the cost per flight issue, and hurts. Yet, if one takes a higher view that it's really space we are trying to get to, and worry more about that and less about the means of getting there, I think that it will all work out, as Congressman Lujan suggested in his comment, it will work out eventually and in the right time, probably, in my view, late nineties, after the year 2000, we'll have a good, healthy national capability, shuttle-like thing to get to space, and we'll probably have some non-shuttle-like things. Just like we have in aviation today.

Mr. NELSON. Do you have any preference as to—your advisory council have any preference of those ELV's that are launching commercial payloads, whether or not they'd be operated commercially or they'd be operated by the Government?

Mr. ANDERS. The government? Our council did not focus on that specific point but it did have an inclination to not get NASA all balled up in an airline operation. I look at NASA as a very big national resource focusing on the space act job of supporting space exploration, science applications, R&D, aeronautics, doing experimentation development in manned and unmanned flight. Even though NASA has done a remarkable job in quote, "operation," unquote, of things like Apollo, I, for one, and I think the task force sort of implied that airline operations, though NASA could—a smart group of guys could probably evolve to that maybe a deevolution away from the more valuable job of the really R&D and exploration focus, therefore, the MARD became operational, routine, boring, efficient—that's probably the job for somebody else. Hence, the recommendation to move that a little bit at this stage of the game away from—away from the NASA development focus.

Our problem is—all of our problems is—when you are only dealing with four or five orbiters, you don't have much of a quote, fleet, unquote, to really run an airline or a spaceline.

Mr. NELSON. Thank you.

Mr. VOLKMER. I now recognize the other gentleman from Florida, Mr. MacKay.

Mr. MACKAY. I gather, Mr. Anders, from your written testimony that a strong point of view in your advisory council was that there should be incremental pricing or that we should take a longer view of this whole cost recovery question in pricing.

Mr. ANDERS. Yes, sir.

Mr. MACKAY. In talking to earlier witnesses in this series of hearings, I got the impression that NASA is committed to a full cost recovery. In fact, we had quite a discussion about "what do you mean full cost?", because it's all kind of a game, full cost is billions and billions of dollars, and they said oh, no, we think that it's appropriate that the cost of sending that flight up and maintaining the overhead, and all of this, has got to be borne by the users. And it's quite apparent to me that once you adopt that policy, you are then driving users into competitive modes and you're cutting down on your numbers of flights. And you're basically, accidentally, or awkwardly, you're backing into a set of policies because of a concern over a cost recovery which is almost like a net as compared to the overall thing we're trying to do.

Mr. ANDERS. Exactly.

Mr. MACKAY. And my question is, How strongly do you all feel about that? And how strongly—because your written testimony says NASA—its got one of these nice sentences—it says NASA advises us that they're taking that into consideration.

Mr. ANDERS. Well——

Mr. MACKAY. Well, NASA advised us they're taking our views into consideration. But it looks like they're charging ahead with full cost recovery.

Mr. ANDERS. Well, Congressman, I certainly don't need to comment to you about the three branches of the Government, but NASA's an executive branch, they work for the President. I don't, I used to but I don't anymore. I'm more of a free spirit, I guess. And I personally strongly believe that there has to be subsidies for shuttle and for ELV launches in order to get to the more important aspect of opening space.

Mr. MACKAY. I think we ought to say we're going to price the shuttle at whatever level we've got to price the shuttle to be competitive with Ariane and anybody else that gets in the business, and they had better understand that.

Mr. ANDERS. That would be, I think, a step in the right direction. My guess is that deep in their hearts NASA would agree with that, though they must salute in the direction of Pennsylvania Avenue when they come up here with their testimony.

The—I would urge, though, that—that we look not so much at the shuttle versus Ariane, or Ariane versus ELVs, or whatnot, and get trapped in what I think is a more shorter term issue, but look again to the more longer term, important point that—that we're really are trying to do. We are—it's the end that we're looking for; the opening up of space like air, like sea, and not so much the means. The means, of course, are what get budgets today, and cause deficits today, and cause valves not to work today, and that kind of thing. And so we can—those are important, but I think small issues compared to the more strategic one. And I mean that not just in DOD, but from a national point of view. And if we can keep in mind the value of space, I think we can then come to more appropriate levels of—of pricing and charging and how to get there at this early stage and we've—we're stuck with today.

Mr. MACKAY. Did your task force work its way back out from the assumption that we might have full cost pricing and try to project from that what the consequences might be in terms of the shuttle. By that, I'm saying it appears that one could follow that out and if the Air Force develops its own system, ELV's, and then the private contractor for that system goes out and undercuts NASA's prices, it appears to me that NASA is sort of being moved into backwater with the shuttle.

Mr. **Anders**. If you went to truly full cost pricing, it would drive the Shuttle out of business immediately if you had to recover R&D cost.

Mr. **MacKay**. It appears to me that one branch of our Government is apparently intent on doing that.

Mr. **Anders**. Well, except that it's—my undertanding is that the Budget Bureau, or OMB, and whatnot, is not demanding that definition of full cost. That—in fact, if the airlines had to pay for FAA and runways, and everything else, you—you couldn't even—well, you'd still have trouble making it from here to New York, but it would be even worse, and a lot more expensive.

So the full—when NASA says full cost, my interpretation that is sort of full ongoing cost.

Mr. **MacKay**. But I've——

Mr. **Anders**. Maybe I'm missing a point.

Mr. **MacKay**. Let me make sure I understand what you're saying.

Mr. **Anders**. Yes.

Mr. **MacKay**. No, I think you are very much on point. I would define incremental costs in a way that said we're going to fly this vehicle as a research vehicle, and it's going to fly every so often anyway, and we've got 10 percent of our available space and the cost of putting something in that 10 percent is an incremental cost. Is that——

Mr. **Anders**. That sounds certainly quite reasonable to me. I would urge that—that when you look back on this period, and whatever price charge, didn't encourage a lot of people to use launchers, shuttle or otherwise, to get there, then we charge too much.

Mr. **MacKay**. That's the way I feel. Thank you very much.

Mr. **Volkmer**. The gentleman from California?

Mr. **Brown**. I have no questions.

Mr. **Volkmer**. I'd like to address a couple questions.

Mr. Stewart, I'd like to get into a little bit on the questions—the spare parts, and how your advisory panel sees that as a safety question.

Yesterday, we had testimony from the Center directors and they seem to think that even in the near term that they had it in about as good a shape as they could considering that we're still in the production line for the fourth shuttle and that many of the things are still in the development stage.

How would you address that as far as the comments that you make on the recommendations in regard to the spares as being tight and priority funding, et cetera?

Mr. **Stewart**. Yeah, well, this is an issue that we have been looking at for several years now. And I think the panel would say that the situation has improved considerably over the past year or so, that finally, after we got through the initial four flights or so, there was a much clearer recognition by NASA that the budgets for—or procurement of spares was inadequate, and there was beefed up—that they were about to face a situation where certain key contractors and—and procurement sources were going out of business, at least as far as NASA space shuttle products were concerned; and they—and they took several initiatives to keep those sources available by placing orders at the critical moments. And—and so that the—the trend is clearly moving in the right direction. I think that perhaps is the thing that I should underline.

You come into particular areas like the space shuttle main engine, and particularly the turbopumps, and that is—that is just a problem which you cannot work your way out of except over a fairly long period of time with a great deal of money. And NASA has got a program which I think the Panel, likewise, feels is a good program. But it's just going to take another year or so before they get any kind of any number of spares that will be readily available and in that interim period there is—they have literally no choice but to continue this unfortunate cannibalization of turbopumps, which, which goes on now almost every flight.

There is a phase 2 program for upgrading the turbopumps, to extending those—to extending their life and that, of course, you know, if that is successful and we think it will be, will mean you'll have to be changing these pumps out less often.

The other—the bottom line for all of us, though, has got to be safety, and you've got to examine those pumps after every flight and—and it's clear that two or three flights in some cases is the absolute maximum you can safely use them, and you've got—you've got to change them out.

This gets right back to what Bill Anders has been saying, and while the panel has not conducted a formal study of NASA management and philosophy of the space shuttle, I think we would unanimously agree with the basic message that Mr. Anders has sounded today about seeing the shuttle as a continuing R&D vehicle in many respects. You want to make it as efficient as you can, you want to—you know, you want to work on turnaround time and do all the things that increases productivity and efficiency, bring down the cost of managing it, but you just simply can't forget that each of those orbiters is different, there are not two articles—orbiters that are identical. And a number of the systems that are presently there now are old, they're 10, 12, 15 years old; they're going to be replaced; the general purpose computers are going to be replaced; the APU's are going to be upgraded and replaced; and so you can just go down the major systems and subsystems and you are going to see a long string of replacements.

All of that has a real R&—kind of R&D ring to it. And an important—all of these are important developments, from a safety point of view, from an efficiency point of view, but they really do suggest that you've got to be willing to pay for these through some kind of sensible subsidy, however you define it, however you want to cloak it and label it, something like that is necessary if the tremendous benefits of a—the space shuttle system are to be ultimately achieved.

Mr. VOLKMER. I'd like to give my viewpoint, too, and I appreciate Mr. Anders testimony and the advisory council on maintaining it as an R&D—now recognizing, at least, is more of an R&D rather than operational thing before you privatize it, realizing that we've had only approximately, I think, 11 flights so far, and two of them haven't even flown yet. And I question even with a—if we had a brand-new type of commercial or even military plane even, that you'd say, hey, we're ready to go at this time. So I think—I appreciate those comments.

The other thing I would like to bring up, Mr. Anders, is the question of fencing. That there's been made a recommendation—and in testimony yesterday in discussing it with the center directors, it appears that there'd be less objection to fencing as far if it remained purely budgetary as far as amounts of money is concerned, but there would be serious problems if you get into the questions of personnel. In other words, you're saying only these certain personnel can be used in the shuttle operation features of the agency. They mentioned times when they've had to transfer people in or bring people in to take care of problems that arise.

Would you like to comment on that in regard to the recommendations that you make in regard to fencing?

Mr. ANDERS. Well, Mr. Chairman, the fencing recommendation may well appear—and may be in reality—somewhat in conflict with my point of this sort of taking the long national view in looking at the shuttle as not—not an R&D vehicle per se, but at least having less operational factors than—than—than an airline. Because the task force did try to look at ways to encourage the operationalability of the shuttle, at least that part of it, again, recognizing that—that there are not very many of them around.

We just felt that—that in that regard it would be good to have a little separation, at least a first step in that direction. We recommended what in retrospect looked to be sort of a full barbed wire fence around the shuttle in between the rest of NASA—NASA has gone sort of halfway in retrospect, I think that's—their move is about right at this stage of the game. Whether they should go further, I think remains to be seen. There would be complications, as you brought up; maybe they can be solved, maybe they can't.

But I'm—I'm satisfied, and I think our committee is satisfied that the move so far is good. Though we did urge that NASA try to objectively—it may be difficult for them—look at ways to see if we couldn't move this a little further on, and we expect to hear back from them in 6 months or a year or so, at how—how they go.

I can recognize the Center Director's view. On the other hand, there are a lot of competent people in and out of NASA that might be segregated to do the operational job as well.

Mr. VOLKMER. Thank you. My time has expired. Anyone on the——

Mr. LUJAN. I yield my time to you, Mr. Chairman, I'm sorry.

Mr. VOLKMER [continuing]. Members—do you have any additional questions? Anyone on this side? The gentleman from Florida have any additional?

I have no additional questions at this time.

Well, maybe we could have a comment looking to the future, Mr. Anders, on this same question—looking to the future as, say, 15 years from now. And let's assume that the shuttle operations have been very satisfactory, and that we, at that time, have almost all of the operational facilities—KSC, Johnson, et cetera, most of the work being done by contracting. Do you see any possibility at that time—and speaking individually now, not a member of the Council—that there could be a possibility of a privatization of these shuttle operations——

Mr. **Anders**. I think so.

Mr. **Volkmer** [continuing]. In regard to the national security and everything else?

Mr. **Anders**. Well, I'm not sure about the national security part. I think that—that's a special and important case. I would like to see in 15 or more years, personally, a commercialization—privatization I guess is the word in vogue today—of launch capability: shuttle and son of shuttle, and so on. I think the Government, though, has to be very careful, quite frankly, in the national security area to essentially have its national security mission be handed over to commercial operation. That's not being done today——

Mr. **Volkmer**. Wait, wait a minute now. I understand, though, that right now when they use the Atlas, that it's the contractor that handles the payload and everything else, and——

Mr. **Anders**. But not the management—I thought you meant the management——

Mr. **Volkmer**. Right.

Mr. **Anders** [continuing]. Of them.

Mr. **Volkmer**. But I—I know we probably have to clarify that. Other than that, you see no objections to go to a commercial——

Mr. **Anders**. Contractor support in—in the days of tight forestructure or the DOD is becoming a way of life, there is a place where you have to stop; you don't have contractors on the front lines; you don't have them up fueling the B-52's.

Mr. **Volkmer**. Right.

Mr. **Anders**. So there has to be a wartime hands-on capability by the military—available and trained. Again, though, for those missions that don't need it, I would hope that we could get that out of the Government and let private enterprise do it.

Mr. **Volkmer**. I have no——

Mr. **Lujan**. It would be nice to have the—a contractor run the war for us, just——

Mr. **Anders**. Well, when I was in the military, I would have been glad to have them to go war instead of me. [Laughter.]

Mr. **Stewart**. Mr. Chairman, I might just, if you——

Mr. **Volkmer**. Yes.

Mr. **Stewart** [continuing]. If it's all right.

Mr. **Volkmer**. Yes.

Mr. **Stewart**. One of the things that always struck me that is being, you know, particularly attractive about some of the American system of government is its capacity to, you know, sort of invent institutional devices for particular sorts of problems that are, you know, really quite, you know, quite unusual. You know, as a space station takes shape and as you begin to see where we're—where we're headed in space, it may very well be that some kind of mixed public, private sort of entity might—might very well be the right kind of thing for the long haul.

And it's just very hard to speculate on that except to say that we have over—you know, over time, as particular problems have arisen, been quite willing and quite flexible and open about coming up with—with sort of new institutional forms.

And in my day-to-day efforts—I work for the Tennessee Valley Authority, and that was a fairly innovative notion back when it was created 50-year—some-odd years ago—fairly, you know, fairly taken for granted now, which I guess is a good thing. But that is a particular capability we've had as a—as a form of government, and I would—I would think we might come up with some very surprising ways of sustaining our space activities that would—that would define real and important roles, both for the private sector as—as it's traditionally viewed, and also—and also the public sector.

And—and the Congress, you know, has—has played a very important role in initiating some of those: COMSAT being a clear example of a—initiative that was very much a congressional initiative. And I have every confidence that the Congress will continue to play that role.

Mr. **Volkmer**. All right, thank you very much. And I want to thank both of you for your testimony here today, and you've been very helpful in our deliberations.

Mr. **Anders**. Thank you, Mr. Chairman.

Mr. **Stewart**. Thank you.

[Answers to written questions for Mr. Anders follow:]

Additional Minority Questions

for William A. Anders

Q: The NAC Task Force felt heavy government use of the STS would make privatization of the Shuttle impractical. Since the manifest currently shows that the government will account for at least two-thirds, and for many years three-fourths, of the launches through 1990, does it make sense to consider commercializing the Shuttle until after this proportion has changed?

A: The Council's Task Force on the Mission of NASA felt privatization of the STS was inappropriate in the near term not primarily because of the large government usage but because the present early state of STS operations and the need for continuing evolutionary development and sustaining engineering support would make operation by an organization other than NASA difficult at this time.

On the other hand, the Task Force on Effective Shuttle Utilization gave less attention to privatization of the STS, generally feeling that the heavy NASA and DOD use of the STS would tend to make privatization premature in the near future. They agreed that this subject should be explored in depth at a later time.

The two Task Forces emphasize the importance of bringing the STS to user-friendly, operational maturity at acceptable costs, while studying the question of future organizational options in greater detail. Only then can an informed decision be made on the future operation of the STS. NASA is currently working on both tasks. As yet, there is no a priori reason to conclude that the present dominance of the STS use by the Government precludes some form of privatization, given a reduction in launch service costs.

Q: The NAC report made several suggestions about the need for NASA to develop a marketing effort which NASA seems to be adopting. What customers should be the top priority for the marketing contractor?

A: At present, the major commercial customers for the STS are the communication satellite operators, foreign and domestic. These should continue to receive priority in the NASA marketing efforts. However, a major emphasis should be directed at R&D customers with a need to fly smaller payloads and experiments to prove concepts leading to possible future commercial uses of space requiring extensive launch and operations services.

Q: The NAC Task Force report commented on the low priority of non-comsat commercial and research payloads. How has this concern been addressed by NASA?

A: Subsequent to the NAC report on Effective Shuttle Utilization, which recommended increased emphasis on research payloads, NASA requested the Council to study alternative ways to fly intermediate size experiment payloads at low cost and with reduced integration complexity. A Council working group has addressed this and its report, which recommends certain streamlined approaches, will be submitted to NASA shortly (with copies forwarded to the Subcommittee on Space Science and Applications). The Council expects NASA to respond affirmatively by adopting the recommendations where feasible.

In a like manner, NASA is expanding its efforts to attract commercial firms to fly appropriate experimental payloads as a part of the Administration's initiative to foster the commercial use of space. A Council task force looked at some commercial efforts late last year, and a new task force will soon be established to maintain oversight of these efforts.

Mr. VOLKMER. Our next panel will be comprised of Mr. John Almond, vice president of Telesat Canada; Mike Lyons, vice president, Space Segment Engineering and Operations, Satellite Business Systems; William Ziegler, Western Union; Mr. Robert Pace, Microgravity Research Association, and Mr. R. Gilbert Moore from Morton Thiokol—and if you all will come to the table.

And we'll start with the way that your names were read. And all of your statements will be made a part of the record in full and you may either review the statement in full or summarize, however you so desire. And we appreciate your being here today, and, Mr. Almond, you may begin.

STATEMENTS OF JOHN ALMOND, VICE PRESIDENT, CORPORATE DEVELOPMENT, TELESAT CANADA; MICHAEL T. LYONS, VICE PRESIDENT, SPACE SEGMENT ENGINEERING AND OPERATIONS, SATELLITE BUSINESS SYSTEMS; F. WILLIAM ZIEGLER, EXECUTIVE CONSULTANT, STRATEGIC SATELLITE PLANNING, WESTERN UNION TELEGRAPH CO.; ROBERT E. PACE, JR., VICE PRESIDENT, MICROGRAVITY RESEARCH ASSOCIATES, AND R. GILBERT MOORE, PROGRAM DEVELOPMENT MANAGER, SPACE SHUTTLE PROGRAM, MORTON THIOKOL, INC.

Mr. ALMOND. Thank you, Mr. Chairman.

Mr. VOLKMER. Would you pull that—you will have to pull that over right to you and speak right into it, otherwise, the reporter has problems.

Mr. ALMOND. Thank you, Mr. Chairman.

I'd like to start with just a little background on Telesat. Telesat Canada is the owner and operator of Canada's only domestic communications satellite system. Its first communication satellite was launched in November 1972 and commercial service started in January 1973.

Telesat's dealings with NASA have been marked by very good cooperation and a 100-percent success. Five of our satellites have been launched on Delta launch vehicles and two have been launched on the shuttle. Two more are scheduled for launch on the shuttle this year.

Telesat has used four different versions of the Delta and has participated in several development programs with NASA to achieve improved performance.

Telesat was one of the first commercial customers to make a reservation on the space shuttle in 1977. We participated in the development and of the integration requirements and procedures for integration of the Payload Assist Module and the spacecraft into the cargo bay.

These activities led to the first commercial flights on STS-5 and STS-7 which carried Telesat payloads. Deployments from the orbiter were nominal as were the subsequent PAM and apogee motor firings resulting in two very good operational communication satellites.

I'd like to now make a few comments about bookings. Telesat was fortunate in having booked shuttle launch requirements for its current series of five satellites sufficiently early to have priority over later comers. The delay in the shuttle did, however, force

Telesat to launch one of that series on an expendable launch vehicle.

Current projections on available or open shuttle launch slots indicate a particularly tight situation and any new, or rescheduled, launch requirements will be hard to fit in. It has been our experience that reschedule—rescheduling that is caused because of customer problems can be more easily accommodated with an ELV than it can with the shuttle.

The ELV's, of course, also have shorter spacecraft and launch vehicle integration periods and some simpler and fewer interfaces; fewer and less complex vehicle systems, and no-post launch operational team or special training requirements. All of these factors lead to shorter lead times and less documentation for the ELV.

Despite these differences in 1981, Telesat booked five additional launches to start in 1988 on the shuttle.

Since Telesat was the first commercial flight, our experience and operation with the shuttle is—can hardly be considered typical. The methodology was developed in real time and we were involved in some 4 years of effort with NASA before the first launch in 1982.

While this was a long and difficult process compared to a spacecraft integration on an ELV, the NASA team displayed a spirit of cooperation and flexibility to the customer's needs which ultimately resulted in successful launches.

Most of the STS processing is now standardized, however, compared to an ELV launch, a shuttle launch requires at least 10 times more documentation and the customers must deal with many NASA interfaces.

At present, this is not a deciding factor in the selection of a launch vehicle, but the associated costs on the customer and his contractors must, of course, be considered. NASA is aware of this—these concerned, and is attempting to streamline the process, but it is our feeling that the integration process with the shuttle is always going to be more complex compared to an ELV just because of the relative complexities of the systems.

One of the consequences of these difference is that launch site operations for an ELV can—is a maximum of 7 weeks, and more likely 5, compared to a minimum of 12 weeks with the STS. We also find that Kennedy Space Center security, the training, and the need for foreign national escort requirements also places additional burden on launch preparation team.

In spite of all this, recent shuttle rescheduling and manifest changes are demonstrated an unexpecting—an unexpected STS flexibility. This appears to be due to NASA's efforts in packaging integration and planning functions by payload elements to reduce lead times. This response is much appreciated by commercial customers.

There are—were instances during the STS–5 and STS–7 prelaunch activities where unexpected events in the last 2 weeks before launch occurred in both payload modification and/or special access or testing after installation of the payloads in the bay. Because of excellent cooperation from NASA and its contractors, the required tasks were completed without perturbing the launch schedule.

In summary, as long as more complex launch operations associated with the shuttle are compensated by low launch cost, TELESAT will continue to use the shuttle for its communications satellite system.

Thank you, Mr. Chairman.

Mr. VOLKMER. Thank you very much, Mr. Almond.

[The prepared statement of Mr. Almond follows:]

Prepared Statement of John Almond

SPACE SHUTTLE USER PANEL

UNITED STATES SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

Background

Telesat Canada is the owner and operator of the only domestic communication satellite system in Canada. Its first communication satellite was launched in November 1972 and commercial service started in January 1973.

Telesat has had a very successful and cooperative history with NASA since the early 1970's. NASA has launched seven Telesat 'Anik' satellites with two more scheduled to be launched on the Space Shuttle within the next year. Telesat has also reserved five additional shuttle launch opportunities for 'replacement' Anik satellites, with the first launch of this follow-on series to be in the late 1980's and continue through 1993.

Telesat has used four different versions of the Delta launch vehicle, and recently has had two launches on the Space Shuttle. A chronological listing of Telesat's launches and the launch vehicles used is provided in Attachment 1. Telesat has undertaken specific development agreements with NASA on various versions of the Delta launch vehicle. Such agreements and financial contributions have provided support to NASA for the commercial viability of these developments while providing a new vehicle to meet Telesat's launch needs in a cost effective manner.

Telesat was one of the first commercial customers to book a Space Shuttle launch in 1977. We have worked with NASA, McDonnel Douglas and Hughes Aircraft on the development and integration requirements of the Payload Assist Module (PAM) upper stage, and spacecraft, into the NASA Space Transportation System. These activities successfully led to the first commercial shuttle flights of STS-5 and STS-7 which each carried Telesat payloads. The deployments from the orbiter, and subsequent PAM performance, were nominal resulting in fully operational Telesat satellites.

Space Shuttle Booking

Telesat was fortunate in having booked shuttle launch requirements for its current series of satellites sufficiently early as to have priority over later customers. The delay in the first operational shuttle flight did require Telesat customer services replanning. In the case of our established services an unplanned launch on an expendable vehicle at extra cost was necessary. Since 1980 there has been minimal perturbation in the Telesat scheduled launch dates due to the early booking priority.

Current projections on available or 'open' shuttle launch slots indicate a particularly tight situation on any new, or rescheduled, launch requirements. Commercial customers could well be faced with the lack of a NASA launch opportunity. Rescheduling can be driven by the customer because of a ground or in-space satellite problem, or by NASA because of an STS situation. Our experience with Expendable Launch Vehicles (ELV's) has been that customer-driven rescheduling can be accommodated more easily because of the dedicated vehicle. We have also seen the interval between ELV launches shortened, by use of overtime, to accommodate either a new launch requirement or to recover from a schedule slip. This is not feasible for the shuttle where 3 shifts per day, and up to 7 days a week is baseline for the standard KSC STS launch preparation flow, and the committed launch schedules. The ELV has the advantage of simpler satellite interfaces, fewer and less complex vehicle systems, and no-post launch operational team or special training requirements. All these factors contribute to shorter lead times, and less documentation, for an ELV launch.

However, consistent with our continuing policy to use the most cost effective launch system, in mid-1981 Telesat booked five additional STS launch opportunities to start in 1988. These launches have been spaced at 15 month intervals to provide implementation flexibility to Telesat, while providing the advantage of an early booking date priority to respond to some of the STS scheduling concerns.

Operational Experience Comparison

Since Telesat was on the first commercial Shuttle flight, our experience of the integration process cannot be considered typical. The methodology was then being developed in 'real-time', and consequently, we were involved in some four years of concentrated effort with NASA prior to our first launch in 1982.

This was a prolonged and difficult process compared to the simplicity of the integration with an ELV and required a lot of adjustment on both sides. However, the NASA team displayed a spirit of cooperation and flexibility to the customer needs which ultimately resulted in outstandingly successful launches.

A new customer today would find most of the STS process standardized; nevertheless, compared to the ELV a shuttle launch requires 10 to 15 times as much documentation from the customer, and he must deal with a dozen or more different NASA interfaces instead of only one or two.

This is not a deciding factor in launch selection, but it is a significant additional burden on the customer and his contractors, with a resultant cost penalty which must be considered in the overall price. We know that NASA is aware of this and is attempting to streamline the processes, but it seems inevitable that it will remain significantly higher than with an ELV just because of the relative complexity of the shuttle.

One of the more obvious areas of STS operations where additional resources are required compared to an ELV is the duration and magnitude of launch site operations. The integration requirements imposed by having multiple payloads on one flight orbiter processing, together with more complex interface testing with the orbiter has increased, for Telesat, the duration of pre-launch programs from a maximum of seven weeks for an ELV to a minimum of twelve weeks for STS. We have also found that KSC security, training and the need for foreign national escort requirements at certain critical facilities has introduced an additional STS related burden on our launch preparation team.

Despite the complexity and extended duration of STS preparation, integration and flight planning compared to the ELV, recent shuttle rescheduling and manifesting changes are demonstrating unexpected STS flexibility. This appears due to NASA's efforts in 'packaging' integration and planning functions by payload element to reduce lead times. This response to meet commercial customer requirements is much appreciated.

Also, there were instances during both STS-5 and STS-7 where unexpected events in the last week or two before launch required both payload modification and/or special access or testing after installation in the orbiter bay. Thanks to excellent cooperation from NASA and all contractors, required tasks were implemented without perturbing the scheduled launch. This demonstrated STS flexibility in a manner thought not to be feasible during the baseline STS integration cycle.

In summary, while we have found that the shuttle undoubtedly produces the required end result, i.e. a cost effective launch, its broader role and extensive support organization impose a greatly increased workload on the customer compared to the ELV, nevertheless, as long as there is a price advantage Telesat will accept this as a necessary penalty.

Contractual Comment

Currently NASA will only contract for launch services to parking orbit. This requires the geosynchronous customer to separately purchase an upper stage and integrate this system with his satellite for NASA interface purposes. The customer is interested in schedule, reliability and total costs to final orbit. If the launch agency were to undertake the upper stage responsibilities, as Ariane currently does and Delta used to, customer obligations would be much reduced. Also, any generic upper stage problems such as have recently been encountered could be handled technically and equitably for all users by a common agency.

It is Telesat's opinion that NASA contracts for both ELV's and specifically the STS unduly protect the United States government. Contractual obligations are particularly onerous on the customer in a manner not normally experienced in commercial agreements. In practice, however, there has been a spirit of cooperation and mutual interest with NASA wherever a problem has developed. NASA is known to be modifying certain of the more severe obligations, but there is still room for improvement.

Future STS Operations Comment

Although the shuttle may never be as flexible as 'an airliner to space' it will approach that goal if operational techniques to insert, or remove, payloads within one month of launch can be developed. Sufficient spare launch capacity is also required to overcome the scheduling shortcomings currently percieved by the communication satellite operators. If a parallel requirement for space-born cargo, without critical schedule requirements, can be developed, e.g. space processing, experimental packages or space station supplies or hardware, then the regular open launch opportunities desired by schedule sensitive STS customers need not cause any under-utilization of the United States Space Transportation System.

Even at today's lower STS prices, communication satellite services are under continuing competitive pressure from new terrestrial technologies. In future years launch system cost will be a critical factor in the commercial viability of certain communication satellite services. Commercial geosynchronous customers will use the launch system offering the lowest overall in-service satellite cost.

ATTACHMENT 1

TELESAT LAUNCHES

Launch Date	Satellite	Launch Vehicle #	Launch Vehicle Type	COMMENT
Nov. '72	Anik A1	Delta 92	Delta 1914	First 'straight 8' Telesat Development Contribution
Apr. '73	Anik A2	Delta 94	Delta 1914	
May '75	Anik A3	Delta 110	Delta 2914	
Dec. '78	Anik B	Delta 147	Delta 3914	
Aug. '82	Anik D1	Delta 164	Delta 3920/PAM	First 3920/PAM Telesat Development Contribution
Nov. '82	Anik C3	STS-5	STS/PAM	First commercial STS
Jun. '83	Anik C1	STS-7	STS/PAM	

Mr. VOLKMER. Mr. Lyons.

Mr. LYONS. Mr. Chairman, I'll summarize the statement I prepared.

On behalf of Satellite Business Systems, thank you for the opportunity to share with the subcommittee our experience as a user of the STS.

SBS provides a wide range of domestic and international advanced telecommunications services for national corporations, large and small businesses, and individual users. SBS uses primarily satellite transmission and was the first company to use Ku-band for commercial purposes. Since its early days as a satellite communications company, SBS has been closely associated with NASA and its advanced space programs. SBS has successfully launched three satellites, the first two on Delta launch vehicles and the third on the shuttle, and is within a few weeks of launching its fourth satellite, also on the shuttle.

SBS prides itself on being a company on the leading edge of telecommunications technology and has participated with NASA in several pioneering space efforts. SBS pioneered with NASA the Delta-39 launch vehicle and was the first operational and deployed payload on the shuttle.

When SBS initially committed to an STS launch, the shuttle was still under development and SBS itself was engaged in the development of an entirely new satellite design. Therefore, we were forced to focus on two very challenging efforts. Our greatest concern is we entered into our satellite development program and nearly concurrently into our NASA launch vehicle service agreement was a potential incompatibility in the development evolution of the two separate space vehicles. We firmly believe that only because of the high level of technical confidence and the management commitment on part of the NASA, SBS, Hughes Aircraft, and McDonnell Douglas team was the first operational deployment on the SBS accomplished in such a flawless manner.

As we embarked on the task of developing our launch strategies with NASA, our principal concerns were the thermal design, deployment techniques, and potential contingency situations that might arise from the uniqueness of the shuttle and its environment. We also attempted to exploit some of the unique benefits of the shuttle by developing procedure for reassessing the condition of our satellite after it had experienced the severe environments associated with the launch, but prior to its deployment from the bay. I'd like to say the STS-5 crew was particularly helpful in this area.

In comparing our shuttle and Delta launches, we have found several significant differences. Our manpower requirements to support a shuttle launch were substantially greater than for a Delta. A Delta launch required two individuals dedicated to the mission. Because the documentation and coordination procedures for launching a communications satellite on a Delta vehicle had been established over virtually two decades of flight experience, little new engineering was required. In contrast, because SBS-3 was the first payload to be deployed from the shuttle, we were parties with NASA in the development of documentation procedures, contingency alternatives, and analyses of flexibility and degrees of freedom of the mission.

We also found that our manpower requirements were influence by the geographic distribution of activities on the two programs. Finally, the multiple payload environment of the shuttle required significant additional engineering effort to verify compatibility.

Now as we approach our fourth launch, and our second shuttle launch, we have found the engineering support requirements have decreased significantly from the first mission. Part of this change can be attributed to the design of our fourth satellite which is very similar to our first three and, therefore, requires few changes in the documentation, safety compliance, and procedures we must meet for NASA. Part of the change is obviously also attributable to the standardization of documentation and our increased familiarity with the documentation procedures, schedules, and personnel. For example, some of the foundation structures developed for our first shuttle mission are now established and no longer require research or substantial exercising with any subsequent PAM users.

Notwithstanding these simplifications, I believe it will always be a more difficult operation to launch on a shuttle than on a typical expendable launch vehicle. The complexity is dictated by the additional flexibility potentially available to a customer such as SBS during the course of the launch and prior to deployment. This flexibility must be explored to finite detail and the crew must be trained to exploit these procedures.

Another inevitable constraint on simplification of the shuttle mission is the very vigilant guard which NASA properly places upon the safety of the astronauts. These safety requirements necessitates substantial demonstration on the part of SBS that its payloads comply with safety rules and require a rather complex series of safeguards and procedures which are sequentially exercised during the deployment so that the proximity of the crew to a potential accident is precluded.

Thus, I think it is inevitable that the costs of the shuttle launch, which, incidentally, more than doubles the processing time at the Cape relative to an expendable vehicle, will always be more expensive in terms of the satellite manufacturer's and the customer's obligations and requirements.

This cost differential, however, is relatively small in terms of the overall cost of the mission and the additional assurance and guarantees the customer derives from the shuttle reliability.

In summary, SBS regards the shuttle as an excellent carrier for transporting communications satellites to orbit that offers an extra measure of reliability relative to the available expendable launch vehicle alternatives.

Initially, we had intended to launch all of our satellites on the shuttle. It was only the lagging development problems in the preflight era of the shuttle, coupled with the critical time constraints of our business commitments, that precluded that plan and required us to launch our first two satellites on the NASA Delta vehicle.

SBS recently signed a contract with Arianespace for the launch services for its fifth satellite, scheduled for launch in late 1986. Our decision to fly on Ariane was dictated principally by reasons of conservative business practice. As we look to a future in which the Delta launch as a backup to shuttle may no longer be available, we are faced with the slight possibility of an extended shutdown of the shuttle program that would thwart SBS's ability to respond with the required communications capacity to meet our customers' needs.

This concern is borne out by experience with expendable launch vehicles, which also have periodically experienced extended delays to recover from failures or damage to vehicles or launch support facilities.

In the case of the shuttle, because of the over-riding concern for crew safety, we can envision situations in which the period of launch prohibition would be quite extensive to permit NASA to conduct a proper investigation to establish the proper confidence level to resume launches. Because of SBS's concern about being unable to respond to its customers demands in a timely and effective manner, it was our decision to become familiar with the alternative launch vehicle that would permit us to respond in a timely manner if one of the alternative launch vehicles were shut down for an extended period of time.

The subcommittee may also be interested in our views about potential improvements in the shuttle operation, which you commuted—were communicated to NASA and believe NASA views positively. Incidentally, the processing time at the Cape has been reduced by almost 4 weeks on this launch relative to our first launch.

A strong emphasis should be placed upon minimizing the processing time required for the customer payloads for the shuttle. The current processing period is 13 weeks and we still regard that as too long. The additional costs associated with the serving—servicing the satellite over that period of time is one consideration. But our major concern is the extended period of time that the satellite is forced to spend exposed to environment unnatural for it and which presents a risk of potential damage.

We also believe that considerably greater standardization should be imposed by NASA on the customer community for such standardized launches as the PAM-D. By standardizing the launches, the documentation procedures can be simplified, the processing time can be shortened, and the overall mission complexity should be reduced. Moreover, the ability of NASA to reconfigure payload manifests quickly would be enhanced, and that would ensure higher bay loadings and more economical missions.

Thank you, Mr. Chairman.

Mr. VOLKMER. Thank you very much, Mr. Lyons.

[The prepared statement of Mr. Lyons follows:]

Statement of Michael T. Lyons
Vice President, Space Segment Engineering and Operations
Satellite Business Systems

Before the Subcommittee on Space Science and Applications
Committee on Science and Technology
United States House of Representatives
August 2, 1984

Mr. Chairman and Members of the Subcommittee:

On behalf of Satellite Business Systems (SBS), thank you for the opportunity to share with the Subcommittee our experience as a user of the STS.

SBS provides a wide range of domestic and international advanced telecommunications services for national corporations, large and small businesses, and individual users. SBS uses primarily satellite transmission and was the first company to use Ku-band for commercial purposes. Since its early days as a satellite communications company, SBS has been closely associated with NASA and its advanced space programs. SBS has successfully launched three satellites, the first two on Delta vehicles and the third on the Shuttle, and is within a few weeks of launching its fourth satellite, also on the Shuttle.

SBS prides itself on being a company on the leading edge of telecommunications technology and has participated with NASA in several pioneering space efforts. SBS was the first user of the Delta 3910 launch vehicle and provided the first practical demonstration of a dual launch vehicle compatible design, which provided the flexibility to adapt a satellite payload to either of two launch vehicles specified to our manufacturer. SBS was also the first commercial firm to sign up for a Shuttle flight, and was a pioneer in the development of the deployment concepts and procedures now employed routinely on the STS for communications satellite payloads. As a culmination of the development activity, the SBS-3 satellite was the first satellite to be deployed from the Orbiter. Our participation with NASA in these pioneering efforts has been an extremely gratifying association for SBS, and we look forward to a continuing successful association with NASA in additional space ventures.

It is difficult to look back and accurately recall the process we went through in developing a satisfactory concept and mission plan for our operational launch on the Shuttle. Since this activity was coincidental with the Shuttle's development and exploitation as an operational transport vehicle, and SBS was also engaged in the development of an entirely new satellite design, we were forced to focus on two very challenging efforts. Our greatest concern as we entered into our satellite development program and, concurrently, into our NASA launch vehicle services agreement was the potential incompatibility that could occur as we progressed through the development and the evolution of the two separate vehicles. We firmly believe it was only because of the high level of technical competence and the dedicated management commitment of the NASA, SBS, Hughes Aircraft, and McDonnell-Douglas team that the first operational deployment of the SBS satellite was accomplished in such a flawless manner.

Initially, we had intended to launch all of our satellites on the Shuttle. Only the lagging development problems in the preflight era of the Shuttle, coupled with the critical time constraints of our business commitments, precluded us from that plan and required us to launch our first two satellites on the NASA Delta vehicle.

As we embarked on the task of relating to NASA in developing our launch strategies, I remember our principal concerns were in the areas of thermal design, deployment techniques and potential contingency situations that might arise due to the uniqueness of the Shuttle and its environment. We also attempted to exploit some of the unique benefits of the Shuttle, in that we developed a procedure for reassessing the condition of our satellite prior to deployment from the bay, but after the payload had experienced the severe environments associated with the launch. I might say that in the course of developing these procedures, in conjunction with our manufacturers and NASA, we saw a tremendous commitment to making the overall Shuttle system work. I particularly want to cite the enthusiasm and dedication of the crew of the STS-5, who spent innummerable hours understanding not only the deployment procedures, but also the functioning of the PAM and of the satellite, so that they would be in an expert position to react to any contingency that might arise during the course of the launch.

In the course of this development process we found that SBS's manpower requirements to staff and support a Shuttle launch were substantially greater than those to support a Delta launch. For a Delta launch we had two individuals dedicated to the support of the Delta mission, working with NASA and Hughes Aircraft to provide the proper specifications, requirements, procedures, and launch processing. Because the coordination and documentation procedures for launching a communications satellite on a Delta vehicle had been established in over virtually two decades of flight experience, procedures required little new engineering.

When we became involved with the Shuttle program, we found that the two persons were not sufficient, and by the end of the development program for the Shuttle mission, SBS had five people dedicated full time. Since SBS constituted the first deployable payload and the first user of the now standardized PAM deployment system, we were partners with NASA in the joint development of documentation, procedures, contingency alternatives, and analyses of the flexibility and degrees of freedom of the mission. Because these foundational structures are now established they no longer require research or substantial exercising with new PAM users.

We further found that the manpower demands were dictated to a certain degree by the geographic distribution of the activities on the Shuttle program. For the Delta missions we required interfacing with the Goddard Spacecraft Center and NASA Headquarters, both local to SBS, and Kennedy Space Center. This situation contrasts sharply with our experience with the

Shuttle where we had to distribute our efforts among NASA, Kennedy Space Center and Johnson Space Center, and a small amount of activity related to Goddard and its tracking network. This simple expansion of our geographic coverage requirements probably accounted for one of the three additional persons required for the Shuttle mission. Finally, the multiple payload environment of the Shuttle necessitated significant engineering effort to verify compatibility.

As we approach this fourth launch, and our second Shuttle launch, we have found the manpower demands for special engineering analysis to have diminished significantly relative to the demands we experienced on the initial Shuttle mission. This change is partially attributable to the fact that this fourth satellite, in virtually all respects, is identical to our prior three satellites. As a consequence, there is very little change in documentation, safety compliance, and other procedures that we must meet with respect to NASA. Part of the simplification of the mission is also obviously attributable to the standardization of the documentation that we now are operating with and to our familiarity with the documentation, procedures, meeting schedules and personnel with whom we must interface.

Notwithstanding these simplifications, I believe it will always be a more difficult operation to launch on a Shuttle than on a typical expendable launch vehicle. The complexity is dictated by the additional degrees of freedom of potentially available to a customer such as SBS during the course of the launch and prior to the deployment. These degrees of freedom must be explored, and spelled out in detail, and the crew must be trained to understand available fallback procedures and SBS's wishes with regard to their exploitation.

Another inevitable constraint on simplification of a Shuttle mission is the very vigilant guard which NASA properly places upon the safety of the crew members. These safety requirements necessitate substantial demonstration on the part of SBS that its payloads comply with safety rules and require a rather complex series of safeguards and procedures which are sequentially invoked during the deployment so that the proximity of the crew to a potential accident is precluded. Thus, I think it is inevitable that the costs of the Shuttle launch, which more than doubles the processing time at the Cape relative to an expendable vehicle, will always be more expensive in terms of the satellite manufacturer's and the customer's obligations and requirements. This cost differential, however, is relatively small in terms of the overall cost of the mission and the additional assurance and guarantees that the customer derives from Shuttle reliability.

In summary, SBS regards the Shuttle as an excellent carrier for transporting communications satellites to orbit that offers an extra measure of reliability relative to the available expendable launch vehicle alternatives.

SBS recently signed a contract with Arianespace for launch services for its fifth satellite, scheduled for launch in late 1986. Our decision to fly on the Ariane was dictated principally by reasons of conservative business practice. As we look to a future in which the Delta launch as a backup to a Shuttle may no longer be available, we are faced with the slight possibility of an extended shutdown of the Shuttle program that would thwart SBS's ability to respond with the required communications capacity to meet our customers' needs. This concern is borne out by experience with expendable launch vehicles, which have also periodically experienced extended delays to recover from failures or damage to vehicles on the launch support facilities. In the case of the Shuttle, because of the overriding concern for crew safety, we can envision situations requiring a lengthy delay to provide NASA with the opportunity to conduct a proper investigation to permit it to reach the proper confidence level to resume launches. Because of SBS's concern about being unable to respond to its customers' demands in a timely and effective manner, it was our decision that it was imperative that we become familiar with the alternative launch vehicle that would permit us to respond in a timely manner if one of the alternative launch vehicles were shut down for an extended period of time.

The Subcommittee may also be interested in our views about the potential improvements in the Shuttle operation, which we have also communicated to NASA and believe NASA views positively. A strong emphasis should be placed upon minimizing the processing time required for the customer payloads for the Shuttle. We regard the current processing period of thirteen weeks as too long. The additional costs associated with servicing the satellite over that period of time is one consideration. Our major concern is the extended period of time that the satellite is forced to spend exposed to an unnatural environment for the satellite which presents a risk of potential damage. We also believe that considerably greater standardization should be imposed by NASA on the customer community for such standardized launches as the PAM-D. By standardizing the launches, the documentation procedures can be simplified, the processing time can be shortened, and the overall mission complexity should be reduced. Moreover, the ability of NASA to reconfigure payload manifests quickly would be enhanced, and that would ensure higher bay loadings and more economic missions.

Mr. Volkmer. Mr. Ziegler?

Mr. Ziegler. Thank you.

My name is F. William Ziegler. I have been employed by the Western Union Telegraph Co. for the last 14 years—

Mr. Volkmer. Mr. Ziegler, will you pull that closer?

Mr. Ziegler [continuing]. In various positions relating to communication satellites. In general, my responsibilities have been those of a program manager for the planning, procurement, launch and operations of communication satellites.

Western Union's Westar system began operations in 1974 with the launches of Westars I and II by NASA using Delta 2914 vehicles. Westar III was launched in 1979, also using the Delta 2914. Westar's IV and V, approximately twice the size and mass of the earlier Westars, were launched in 1982 using NASA's Delta 3910's plus McDonnell Douglas Payload Assist Modules as the upper stages.

All five of these satellites achieved geosynchronous orbit and have performed in accordance with, or better than, the design objectives.

Westar VI is a different story. In December 1981, Western Union contracted with Arianespace for a launch on Ariane from Kourou, French Guiana. This decision to use Ariane rather than Delta was based on economics. Not only was the price substantially lower, but the Arianespace arranged a very attractive financing package. Even though the space shuttle would have been less costly than Ariane, the many extensive delays in the shuttle development program indicated to us that any scheduled commitment would be uncertain.

In restrospect, the judgment was somewhat faulty because NASA did complete its developmental flights with only minor delays during the year following our decision.

In September 1982, Ariane had a third stage failure which caused significant schedule delays for future Ariane launches and motivated Western Union to reevaluate the possibility of using the space shuttle for the launch of Westar VI.

In early 1983, Western Union did contract with NASA for a shuttle launch in January 1984 and terminated the Arianespace contract. NASA was extremely cooperative during our decision process and booked our launch a mere 10 months in advance of the launch date.

As you know, Westar VI was launched in and deployed from Challenger on February 3, 1984. The PAM upper stage ignited 45 minutes after deployment as planned, but failed to provide the necessary impulse to place Westar VI in the proper orbit. A few days later, Palapa B-2, suffered a similar fate.

Our next Westar is currently under construction as scheduled for launch on space shuttle in late 1985.

In summary, I'm speaking from our experience of booking and carrying out five Delta launches, booking two and carrying out one shuttle launch and booking one Ariane launch.

In general, we found the book—booking process, that is, the agreement as regard to schedule, technical aspects, price and payments, and other terms of conditions to be relatively straightforward in all cases.

This process for an Ariane launch was somewhat more difficult primarily because of their lack of established policies for providing launch services to commercial customers.

However, after the basic agreement is completed, it is necessary to establish the detailed payload requirements and interfaces to—and to work these to be compatible with the particular launch vehicle and the requirements of other payloads on the same mission.

This activity is far more complex for the space shuttle than for an expendable launch vehicle for several reasons:

First, additional safety requirements are necessarily imposed for a manned space flight.

Second, it is more difficult to resolve the requirements of several payloads on the shuttle than the one or two on expendables. In addition, integration of multiple payloads into the cargo bay imposes additional lead-time requirement on the customer for delivery of the payload.

Third, the shuttle requires the customer to make an extra go/no-go decision for the deployment. This is further aggravated by the fact that the astronauts actually perform this operation and must have training and documentation to cover all conceivable contingencies since the actual deployment may occur when the shuttle is not in radio contact with the ground.

Even though shuttle operations provide an opportunity to evaluate the payload after launch and before deployment, this advantage is a dubious one because, first, the amount of health information one can obtain about a payload in its launch/deployment configuration is quite meager; and, more importantly, the economic penalty of a no-go decision is so great that one would make that no-go decision only if one were certain that the payload would not work if deployed.

In fact, in the case of Palapa B-2, the decision to deploy was made in spite of the unexplained Westar PAM failure a few days earlier.

Fourth, the customer must deal with two operating centers—Kennedy and Johnson—for a shuttle launch, where it needs to deal with only one for an expendable launch.

Now, there's one other point I'd like to make which perhaps pertains more to—to contrasting commercialization of launch activities than to the space shuttle versus expendable in particular.

Goddard Space Flight Center established a Flight Readiness Review Committee many years ago which continuously reviewed the design, development, manufacture, and test of the Delta launch vehicle.

As a Delta user, we found it very comforting that this group of experts were continuously tracking all these activities, would conduct the flight readiness reviews and would approve a vehicle's flight readiness status. This independent review function was not available for the commercialized PAM upper stage and it is not clear that such an independent function exists for the shuttle itself.

In the fields of communications and electronics, customers such as Western Union can muster the necessary skills to substitute for this loss, but find it impossible to attract and retrain—retain the necessary talent to perform this function for propulsion systems.

We simply do not launch enough satellites to provide a broad base of experience in the propulsion field.

We do support commercialization, but believe NASA, or some other Federal agency, should establish and maintain an independent capability to provide this continuous review and flight readiness approval function for all propulsion systems designed or manufactured within the—within the United States.

In conclusion, I offer the following recommendations for your consideration:

First, NASA should be encouraged to continue its review of safety requirements and payload processing operations with the objective of reducing the burdens imposed on—upon the customer without compromising crew and orbiter safety or reducing the probability of mission success.

Second, consideration should be given to improving the relaunch provisions of the launch service agreement to make it easier for a customer to make a no-go decision for deployment when the payload status is doubtful. The current provision imposes too long a delay for relaunch and is too expensive.

Third, centralization of shuttle operations at Kennedy Space Center would simplify the customer's operations and coordination problems, and may provide some economies for NASA to help keep it more competitive. The reduced workload at Johnson Space Center would permit greater attention to the space station project.

Fourth, consideration should be given to pricing changes more frequently and of smaller magnitude than the 3-year intervals. The current procedure has made September 1985 a very popular launch month and continuation of this 3-year revision cycle can only continue to create such situations which motivate both NASA and its customers to compromise their otherwise sound technical and business judgments.

Fifth, in the past few years we have seen a number of propulsion-system failures which have caused launch delays, compromise of objectives, and catastrophic failures. These include an Arianne third stage; an IUS upper stage; two PAM–D's; a Centaur; and most recently, a shuttle main engine. These events have caused traumas not only to the launch agencies and their customers, but have triggered a major upheaval in the insurance industry. Also, I believe our national pride is at stake.

Therefore, it is strongly recommended that an independent review function be established within NASA or another Federal agency to continuously review of the design, manufacture, qualification, and test of all propulsion systems designed and manufactured within the United States.

Mr. Chairman, I would like to express my appreciation to the subcommittee for this opportunity to express my views on the space shuttle and launch operations; and this concludes my oral statement.

[The prepared statement of Mr. Ziegler follows:]

July 30. 1984

TESTIMONY OF F. WILLIAM ZIEGLER BEFORE THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY OF THE U. S. HOUSE OF REPRESENTATIVES, AUGUST 2, 1984.

My name is F. William Ziegler. I have been employed by the Western Union Telegraph Company for the last fourteen years in various positions relating to communication satellites. My current title is Executive Consultant, Strategic Satellite Planning. In general, my responsibilities have been those of a Program Manager for the planning, procurement, launch and operations of communication satellites.

EXPERIENCE

Western Union's Westar system, the nation's first domestic communications satellite system, began operations in 1974 with the launches of Westars I and II by NASA using Delta 2914 vehicles. Westar III, launched in 1979, also used the Delta 2914. Westar's IV and V, approximately twice the size and mass of the earlier Westars, were launched in 1982 using NASA's Delta 3910's plus McDonnell Douglas PAM's (Payload Assist Modules) as the upper stage. All five of these satellites achieved geosynchronous orbit, 22,300 miles above the equator, and have performed in accordance with, or better than, the design objectives. Westar I was retired in 1983, more than nine years after launch even though it was designed for a seven year life. Westar II will be retired when our next satellite is successfully launched (scheduled for December 1985) or when it runs out of fuel, whichever occurs first.

Westar VI is a different story. In December 1981, Western Union contracted with Arianespace for a launch in December 1983 on an Ariane 3 from Kourou, French Guiana. This decision to use Ariane rather than Delta was based on economics. Not only was the price substantially lower, but Arianespace offered a very attractive financing package via European banks. Even though the Space Shuttle would have been less costly than Ariane, the many extensive delays in the Shuttle development program indicated to us that any schedule commitment would be uncertain. In retrospect, this judgment was somewhat faulty because NASA did complete its developmental flights with only minor delays during the year following our decision to use Ariane.

In September 1982, Ariane had a launch failure due to the third stage turbopump. This event caused significant schedule delays for future Ariane launches and motivated Western Union to reevaluate the possibility of using the Space Shuttle for the launch of Westar VI. In early 1983, Western Union did contract with NASA for a Shuttle launch in January 1984 and terminated the Arianespace contract in accordance with its terms and conditions. I should add that NASA was extremely cooperative during this decision process. NASA was able to book our launch a mere ten months in advance of the launch date.

As you know, Westar VI was launched in and deployed from the cargo bay of Challenger on flight STS-41B, on February 3, 1984. The PAM upper stage ignited forty-five minutes after deployment as planned, but failed to provide the necessary impulse to place Westar VI in the geosynchronous transfer orbit. As a result Westar VI is in an unusable low orbit. A few days later, an Indonesian satellite, Palapa B-2, suffered a similar fate.

Westar VII (sometimes called Westar VI-S, the S meaning "Successor") is currently under construction and is scheduled for launch on Space Shuttle in late 1985.

In summary, I am speaking from our experience of booking and carrying out five Delta launches, booking two and carrying out one Shuttle launch and booking one Ariane launch.

THE BOOKING PROCESS

In general, we have found the booking process (that is, the agreement as regard to schedule, technical aspects, price and payments, and other terms and conditions) to be relatively straight forward in all cases. The process of booking an Ariane launch was somewhat more difficult primarily because of their lack of established policies for providing launch services to commercial customers.

After the basic agreement is completed, it is necessary to establish the detailed payload requirements and interfaces and to work these to be compatible with the particular launch vehicle and the requirements of other payloads on the same mission. This activity is far more complex for a Space Shuttle launch than for an expendable launch for several reasons:

1. additional safety requirements are necessarily imposed for a manned space flight;
2. it is more difficult to resolve the requirements of several payloads on Shuttle than the one or two on expendables. In addition, integration of multiple payloads into the cargo bay, imposes additional lead time requirement on the customer for delivery of the payload;
3. the Shuttle requires the customer to make an extra "go/no-go" decision for the deployment. This is further aggravated by the fact that the Astronauts actually perform this operation and must have training and documentation to cover all conceivable contingencies since the actual deployment may occur when the Shuttle is not in radio contact with the payload experts on the ground. Even though Shuttle operations provide an opportunity to evaluate the payload after launch and before deployment, this advantage is a dubious one because (i) the amount of health information one can obtain about a payload in its launch/deployment configuration is quite meager, and (ii) the economic penalty of a "no-go" decision is so great that one would make that "no-go" decision only if one were certain that the payload would not work if deployed. In fact, in the case of Palapa B-2, the decision to deploy was made in spite of the unexplained Westar PAM failure a few days earlier;
4. the customer must deal with two operating centers (Kennedy Space Center and Johnson Space Center) for a Shuttle launch whereas it needs to deal with only one for expendable launches.

There is one other point I would like to make which pertains more to commercialization of launch activities than to the Space Shuttle in particular. Goddard Space Flight Center established a Flight Readiness Review Committee many years ago which continuously reviewed the design, development, manufacture and test of the Delta launch vehicle (and all payloads for which the Center had responsibility). As a Delta user, we found it very comforting that this group of experts were continuously tracking all these activities, would conduct the Flight Readiness Reviews and would approve a vehicle's flight readiness status. This independent review function was not available for the commercialized PAM upper stage and it is not clear that such a function exists for the Shuttle itself. In the fields of communications and electronics, customers such as Western Union can muster the necessary skills to substitute for this loss, but find it impossible to attract and retain the necessary talent to perform this function for propulsion systems. We simply do not launch enough satellites to provide a broad base of experience in the propulsion field. We support commercialization, but believe NASA, or some other Federal agency, should establish and maintain an independent capability to provide this continuous review and flight readiness approval function for all propulsion systems designed or manufactured within the United States.

RECOMMENDATIONS

1. NASA should be encouraged to continue its review of safety requirements and payload processing operations with the objective of reducing the burdens imposed upon the customer without compromising crew and orbiter safety or reducing the probability of mission success.

2. Consideration should be given to improving the relaunch provisions of the Launch Service Agreement to make it easier for a customer to make a "no-go" decision for deployment when the payload status is doubtful. The current provision imposes too long a delay (for relaunch) and is too expensive.

3. Centralization of Shuttle operations at Kennedy Space Center would simplify the customer's operations and coordination problems. It may also provide some economies for NASA to help keep it more competitive. The reduced work load at Johnson Space Center would permit greater attention to the Space Station project at that Center.

4. We now have a situation wherein the price for a Shuttle launch almost doubles at the beginning of government fiscal year 1986 and this new pricing policy is supposed to apply through GFY 1988. If pricing changes are required, consideration should be given to having them more frequently (and smaller in magnitude). The current procedure has made September 1985 a very popular launch month and continuation of this three year revision cycle can only continue to create such situations which motivate both NASA and its customers to compromise their otherwise sound technical and business judgments.

5. In the past few years we have seen a number of propulsion system failures which have caused launch delays, compromise of objectives, and catastrophic failures. These include (i) an Ariane third stage, (ii) an IUS upper stage, (iii) two PAM-D's, (iv) a Centaur, and (v) most recently a Shuttle main engine. These events have caused traumas not only to the launch agencies and their customers, but have triggered a major upheaval in the insurance industry. Also, our national pride is at stake.

Therefore, it is strongly recommended that an independent review function be established to continuously review the design, manufacture, qualification and test of all propulsion systems designed and manufactured within the United States. This function could be implemented within NASA or another federal agency. This function should have the power and the charter to:

1. Continuously review the design, manufacture and test of all propulsion systems provided within the United States, whether under government contract or under a commercialization agreement.
2. Chair special reviews and Flight Readiness Reviews with all affected parties at appropriate times.
3. Provide approval for launch. A non-approval, or lack of approval shall be construed as an absolute veto.

Naturally, no amount of review can guarantee that failures will not occur. Nevertheless, we should do all we can do to reduce the number of such occurences.

I would like to express my appreciation to this subcommittee for the opportunity to express my views on the Space Shuttle and launch operations.

FW Ziegler

F. W. Ziegler

FWZ-25.5:mb

Mr. **Volkmer**. Thank you very much, Mr. Ziegler.

Mr. Pace.

Mr. **Pace**. Thank you, Mr. Chairman and members of the subcommittee.

I'll summarize my written statement, which has been submitted, if I might.

The shuttle is a very sophisticated, reusable space vehicle with flexibility to support a variety of payloads, from delivery of a payload to Earth orbit, to becoming a scientific laboratory in space. And in all of the shuttle missions, man is available on board to participate in the payload operations; and that man can be a member of the scientific community or industrial community.

The shuttle can return a payload for evaluation, refurbishment, reconfiguration, or repair, and can be flown again. This can be a rather significant savings in payload development since the hardware can be used many times.

There is concern with the cost of shuttle operations. The scientific community sees it requiring dollars that could be used for more scientific experiments in space.

Members of the industrial community such as MRA, are concerned that the cost will inhibit the market for space-produced products.

NASA is sensitive to the shuttle operations cost. We are aware of steps that they are taking to reduce costs and are confident that there are steps being taken that we are not aware of. NASA should continue with an aggressive effort to reduce the costs of shuttle operations.

The shuttle is limited to missions of approximately 7 to 10 days. Longer duration missions would benefit a number of payloads. The crystal-growth system, planned by MRA, can produce three times as much on a 21-day mission as can be produced on a 7-day mission at about one-half the cost.

While a longer duration shuttle is highly advantageous to a number of payloads, careful engineering and cost analyses should be made to determine the practical limits before an effort is started to extend it.

The invitation from the subcommittee stated the shuttle has had almost 2 years of operational use. It is more difficult than might be envisioned to transition from an R&D vehicle to the operational phase. The airlines are frequently cited as an example for the operational shuttle. It is not practical to expect the shuttle to operate as routinely as the airlines because the shuttle is more complex and the payloads, and the purpose of the flights, are significantly more complicated. However, the airline model does have a number of features that should be considered.

There should be an understanding that the shuttle now is in the business of providing transportation and other services to customers. And the attitude toward the customer should be the same as any business that depends on the customer for survival.

A popular expression in the personal computer industry is "user friendly," which means it's easy to use. The entire operational system should be user friendly, from the hardware interfaces to the set of requirements that the user must satisfy in order to fly.

From the user standpoint, it must be easy to get a flight assignment, the assignment must be firm and the mission on schedule.

NASA has currently in use a number of methods for encouraging commercial participation. These are effective and should be continued.

The recently announced policy on commercial use of space includes initiatives designed to encourage space ventures. These initiatives, as we understand them, should be implemented. In addition, it is suggested that a system of deferred payment for shuttle use be considered.

We do not believe it is appropriate for NASA or any other Government agency to provide seed money or loan guarantees. Further, any changes in current tax laws and regulations should encourage research and development in general, and should put space and terrestrial projects on an equal basis.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Pace follows:]

STATEMENT OF ROBERT E. PACE, JR.

SPACE TRANSPORTATION SYSTEM

The Shuttle is a very sophisticated space vehicle with flexibility to support a variety of payloads. In its simplest mode it can provide transportation for the delivery of a payload to a predetermined position in low earth orbit. With any one of the possible Spacelab configurations installed in the payload bay it can become a laboratory providing housing and support to a collection of sophisticated multi-diciplined scientific instruments. Selection of one of the Spacelab configurations with a habitable module provides a shirt sleeve environment in which man can work. The Spacelab 1 mission that flew late last year is a good example of this configuration.

There are two types of users, one where the payload, like a satellite, is transported into space and ejected, and one where the payload stays on board the Shuttle and is returned to earth.

In all of the Shuttle mission configurations, man is available on board to participate directly in the conduct of the scientific investigations, as required. It offers the opportunity for experts from the scientific and industrial community to be on board. Members of the scientific community have already flown, and payload specialists have been selected from industry for future flights.

The Shuttle provides the capability to return a payload from a mission where it can be evaluated, refurbished, reconfigured, or repaired, and flown again. This can be a significant savings in instrument development costs since the hardware can be used many times. The ability to return and repair an instrument becomes more significant as the cost of operations are reduced, as it allows a trade between the cost of instrument reliability and the cost of reflight.

COST OF OPERATIONS

There is concern with the costs for the operation of the Shuttle. Members of the scientific community are concerned because they see it requiring dollars that could be used for the development of instruments for the conduct of more scientific experiments in space. Members of the industrial community that want to make commercial flights, such as MRA, are concerned that the cost of Shuttle use will cause the price of space products to be so high the market will be severely inhibited.

NASA is sensitive to the Shuttle operations costs, as evidenced by the cost reduction actions they are taking as they move into the operational phase. We are aware that integration contracts now emphasize the operational mode, and studies have been, or are being made, to identify ways of lowering the cost of instrument development, and the integration and operation of missions. We are confident there are other activities which we are not aware of. NASA should have a strong and continuing effort to find ways to reduce the cost of Shuttle operations.

SHUTTLE UPGRADE

The Shuttle, flexible as it is, is limited to missions of approximately seven to ten days. Its utility would be enhanced considerably if it could support longer duration missions.

MRA plans to produce semiconductor material (crystals) in space. A crystal growth system such as that planned by MRA can grow one batch of crystals on a seven day mission. On a twenty one day mission, the same system can grow three batches, or three times as much. A preliminary cost analysis, using user fees based on a shared payload and paying full cost for days on orbit, show the cost per pound for crystal grown on a twenty one day mission can be approximately one-half as much as the cost per pound on a seven day mission.

While a longer duration Shuttle is highly advantageous to a number of payloads, careful engineering and cost analyses should be made to determine the practical limits. It is not practical to make the Shuttle a free-flyer, or a space station.

USER INTERFACE

The enclosure to the letter of invitation from the Subcommittee states the Shuttle has had almost two years of operational use. It is more difficult than might be envisioned to transition from the R&D to the operational phase. The operational mode is a different way of doing business and requires time to make the necessary adjustment. The airlines are frequently cited as an example for the operational Shuttle. It is not practical to expect the Shuttle to operate as routinely as the airlines because the Shuttle is more complex, and the payloads and the purpose of the flights are significantly more complicated. However, the airline model does have a number of features that should be considered.

A part of the transition to the operational phase is the development of an understanding that the shuttle is now in the business of providing transportation and other services to customers. The customers are the scientific community, the industrial users, and the military. The attitude toward the customers should be the same as any business that depends on the customer for survival.

A popular expression in the personal computer industry is "user friendly", which means it is easy to use. NASA should have a continuing effort to make the Shuttle easier to use. The entire operational system should be user friendly, from the hardware interfaces to the set of requirements the user must satisfy in order to fly.

From the user standpoint, it must be easy to get a flight assignment, the assignment must be firm and the mission on schedule. All delays are costly to the payload developer, regardless of the cause.

INCENTIVES FOR COMMERCIAL USERS

A typical commercial venture in space has a much longer period for return on investment than a typical industrial investment. This causes investment in space ventures to be less attractive.

NASA has currently in use a number of methods for encouraging industry participation, such as the Technical Exchange Agreement (TEA), the Joint Endeavor Agreement (JEA), and the Memorandum Of Understanding (MOU). These are effective and should be continued.

The recently announced National Policy on Commercial Use of Space includes a number of initiatives designed to encourage space ventures. These initiatives, as we understand them, should be implemented. In addition, it is suggested that a system of deferred payment for Shuttle use be considered. The deferral would permit time to market the space product before payment of the use fee.

While we have heard suggestions to the contrary, we do not believe it is appropriate for NASA, or any other government agency, to provide seed money, or loan guarantees. Further, any changes in current tax laws and regulations should encourage research and development in general, and should put space and terrestrial projects on an equal basis.

COMPARISON WITH EXPENDABLE LAUNCH VEHICLES

Payloads that fly on expendable launch vehicles, or ejected from the Shuttle, must perform properly on the first flight. As a result, extra resources are usually spent to assure a highly reliable payload, and to verify that reliability. These payloads are used only on one mission. Payloads that operate on the Shuttle, and that are returned to earth, can be reused on subsequent missions. The return of the payload offers the opportunity to accept higher risks of failure than would be acceptable for a single flight on an expendable launch vehicle. The user must be offered quick reflight opportunities in order to capitalize on this advantage of the Shuttle.

Both Shuttle and expendable launch vehicle flights are concerned with mission safety, and must assure that a payload element, in its normal operation mode or failure mode, will not endanger the mission or another payload element.

Shuttle missions have the additional concern of crew safety that requires additional safety measures in the habitable area. However, the advantage of having man present has been demonstrated many times, and should offset any additional effort.

Mr. Volkmer. Thank you, Mr. Pace.

Mr. Moore.

Mr. Moore. Mr. Chairman, my name is R. Gilbert Moore. I am employed by the Wasatch Division of Morton Thiokol, Inc., in Brigham City, UT, and I have an appointment as an associate—as a—as a professor of physics at Utah State University on an adjunct basis.

What I would like to do this morning is discuss the little end of the business—we're last on the program and very definitely least. The—their—Bob referred to a program—a system called user friendly. Well, there are three or four examples that NASA has which are truly user friendly, and those are the ones that I'm privileged to be associated with and would like to comment on this morning.

The first of those is the getaway special program in which anybody in the world can rent 200 pounds and 5 cubic feet of space, or smaller amounts, for a few thousand bucks, which is an absolutely incredible bargain, and it's getting better every year because it doesn't escalate as inflation comes along. And one can utilize that space for any legitimate scientific or engineering purposes—that's the first program. Now, that's about to evolve into what's called the hitchhiker program, and the hitchhiker is today user friendly. And one of the reasons that I came today is to make sure that it stays user friendly, and I'll have a comment about that a little bit later on.

The second program that NASA has is called the LDEF, or the long-duration exposure facility—that's another user friendly program I'll describe for just a moment.

And the third is the shuttle student involvement project, with which I'm also associated, and that is incredibly user friendly.

What NASA has decided to do, and decided back in 1976 when John Yardley was the Associate Administrator for Space Flight, was to try to incentivize uses of the space program, and to bring in a new generation of investigators who would fill the gap that had developed in the ages of people in the space business. I'm typical of the age of the people in NASA and outside NASA today in the space program, and that's kind of a frightening thing. There was a gap that developed when the intellectual and the physical elite nature of the space program denied access to space. And that was an inevitable thing back in the Mercury and Gemini and Apollo days, and so forth. And the objective of NASA was to try to change that and to give a new opportunity for people to come forth who were of another age group. And I've had the happy privilege of being associated with the start of that—the getaway special program—since it was first announced on October 11, 1976, in Anaheim.

And in that particular activity, many small organizations and university groups, and individuals, and high schools, and everybody you want to think of have bought space on the shuttle and have flown experiments.

I'm participating in a 2-day getaway special symposium at the Goddard Space Flight Center right now, and there are 300 attendees. There are over 400 reservations for getaway special space ranging from the 1½-cubic-foot to the 5-cubic-foot canisters, and these are from countries all over the world. There's a group from Japan, and from Denmark, and from Germany, and so forth. And many of these organizations have no other manner of accessing space except through the getaway special program. And it is a very significant activity, and is one of NASA's shining stars, as far as I'm personally concerned. And that's become apparent from the proceedings of the last 2 days at Goddard.

Good, substantive science is being done, and interesting contacts with space people have been experienced by our Nation's and other nations' youths as a result of this program.

And, now, the getaway special is a fine thing and I'm very much in favor of it, and I think most people are. It is now evolving into what's called the hitchhiker mode in which other services other than just a ride are being supplied by NASA.

In the beginning, the getaway special had only a canister with no connection to the orbiter of an electrical nature, you had to use a G switch to start the thing—that was the original concept—you had to supply your own can; that had to come out of your 200-pound assignment. And all of that has now evolved to the point that NASA supplies a thoroughly tested canister that does not come out of your weight assignment. It weighs more than 100 pounds, but they made the 200-pound and 5-cubic-foot capability net—and that was a great, big boon. Then they connected up some electrical contacts to the cockpit and hooked up an autonomous payload controller; handed it to the astronauts and said, "Now, turn these things on and off, these experiments along in the timeline when you can, and when you're not doing other things like RCS burns to louse up the materials processing experiment." That was a major improvement.

Then they came along and said we'll have an optical window if you would like one. Then they came along and said, "OK, we'll have a lid, an opening lid so that you can, in fact, expose things truly to the space environment, both from a vacuum standpoint and an optical standpoint." That was a major improvement.

One that I have had the privilege to associate with recently is another major step forward in which we're going to eject a free-flying satellite from a getaway special canister on the 51-B mission in January on the spacelab 3 flight.

First of all, it was neat that they accepted us on a spacelab flight, which is the first time any cargo other than spacelab cargo have been accepted.

Second, to have the opportunity to eject a satellite in independent orbit is a major step forward. This particular satellite is a multiple university and multiple aerospace company free experiment to calibrate FAA radars and radars of other countries around the world, and military radars of—in the air traffic control system. And that one is going to be an exciting development.

Now the next step that we envision is a small auxiliary propulsion system that we would like to test in that one involving carbon dioxide as a propellant, and we would like to adjust the orbits of these satellites to higher altitudes.

Shuttle orbits are not really wonderful so far as lots of satellites are concerned. You don't stay up long enough, and you don't stay at a high enough latitude. So we would like to test an independent propulsion system next, and I think that's going to be accepted.

Hitchhiker is the next evolutionary step in which other services will be supplied, such as power, controls, data handling, cooling, and the like. That's going to cost more bread. It will probably run in the neighborhood of $100,000 to $150,000 but, again, will be an incredible bargain, and the concern that I have about that is that we feel that the Hitchhiker should be—we—many of us in the business feel that the Hitchhiker should be an evolution of the getaway special and should be a scaled up getaway special rather than a scaled down spacelab.

Now my friend and colleague, Bob Pace, has spent many years in the spacelab business and realizes that there is a place for a Hitchhiker which is a smaller spacelab. Many experiments that fly on spacelab could fly more effectively, independently, on a Hitchhiker mode, and there's a role—there's a role for that.

There is also a role for a Hitchhiker which is a scaled up getaway special, with the paperwork and the regulations and the concerns consistent with that point of view. There are two mindsets involved, and I think we have to have room for both. That's my one concern that I intend to express today.

The Long Duration Exposure Facility Program—well, pardon me. The Getaway Special Program is managed out of NASA-Goddard. The Long Duration Exposure Facility Program is managed out of the Langley Research Center, and, again, it has been made incredibly user friendly.

There is an LDEF circling above the Earth at this present moment. It will come back down again next year after about 11 months or so in orbit, and it carries 57 different experiments from many investigators and many countries, and it's—it's very much like the Getaway Special Program, except it's one big package that carries a whole bunch of things at the same time. They're basically passive experiments.

Many of the investigations being conducted will have impact on space station design and architecture, because they will be of materials that will be useful to that kind of machine.

The third program is the Shuttle Student Involvement Project, and that one is one in which ten young people are selected from high schools around the country per year by the National Science Teacher's Association, under contract to NASA for the screening purpose, and these 10 young people are then turned over to industry sponsors, and my company happens to sponsor a couple of them.

In fact, we are involved in three exercises: one, and a reflight of that one, and another student—a new one; and in this particular program, there are incredible opportunities given, because astronaut time up to an hour is made available, you have the access, you're in a mid-deck locker with your experiment, and consequently you don't have to worry about thermal swings out in the cargo bay; you have cabin atmosphere; and this program has brought forward some of the most fantastic young minds that I have ever had the privilege of associating with, and after 15 years at New Mexico State University and my last 22 years' association with Utah State University, I've seen some awfully bright young people, but these people are really talented folks, and they're coming into the space program providing that cadre of new talent that NASA so definitely is after.

That is another one of the very fine user-friendly programs, and I would like to make an observation of an historical nature, if I might, to wrap up my testimony. I see Terry is looking at the clock.

I'm—I'll make this one last comment. He who ignores the past is doomed to relive it, as I recall, and I'm reminded that in 1946 the first V-2 rocket flew from New Mexico's White Sands Proving Ground, or then it was called—yeah, that's what it was called then; it's now White Sands Missile Range, and—on—for a series of years, there were 63 flights of the V-2 rocket, and it was interesting.

There's an interesting parallel here. Let's see if I can remember the number—the organizations involved. They were, in those flights—the users were: the Naval Research Laboratory, the Air Force Cambridge Research Center, the Army Signal Corps, the University of Michigan, the Johns Hopkins University, Princeton, Harvard, and Cal-Tech, in the period from June 28, 1946, to September 19, 1952.

Now the V-2 was the shuttle of its day, because many agencies, many investigators, all flew at the same time in the V-2.

They became a bit restive after a while, because somebody's experiment would crump out, and somebody else would have a schedule impact as a result of that. So people began to be restless, and the military were the first to pull out, and the Naval Research Laboratory moved over and developed the Viking—not the thing that went to Mars but the Viking Sounding Rocket—and they had their own vehicle which they flew 12 times, starting in 1949.

Just after the V-2 really started getting operational, they went over to their own launch vehicle, and they flew 12 flights and then went on into the Vanguard program.

But it's interesting that—that there was a harmonious relationship between universities and government agencies for a time, and then they became restless and decided to go to single-purpose launch vehicles.

That was followed by the development of the Aerobee Program and then a whole series of solid propellant sounding rockets that went all the way down to 50-pound payload classes instead of the 2,000-pound weight carrying capability of the V-2, and then it all cycled back up again, and now today there are lots of rockets being launched from various parts of the globe with multiple agencies and multiple investigators all in the same cargo bay again.

The parallel is obvious in the case of the shuttle. We will, in fact, see a trend where the single purpose rocket—the launch vehicle—will take some of the business away, and we will see a swing back to a multiple-use, customer-friendly system, and I don't think that, in the historical context of things, that we have very much to worry about.

I think the shuttle will be here for a very long time to come, and I do think there's room for some expendable launch vehicles, and I don't see the—the terrible problem between those two.

Thank you very much.

[The prepared statement of Mr. Moore follows:]

PREPARED STATEMENT OF R. GILBERT MOORE

Mr. Chairman, thank you for your invitation to appear as a witness on this Space Shuttle user panel. As suggested by members of your staff, I shall discuss my experiences with the small-scale, quick-reaction end of the Space Shuttle payload spectrum and compare them with a similar experience or two in the expendable launch vehicle field. I shall also comment on trends in Shuttle customer services policies.

My Shuttle user credentials are in the areas of the Getaway Special program, the Shuttle Student Involvement Project (SSIP), the Long-Duration Exposure Facility (LDEF) and the Hitchhiker program. I have been involved in launches of three Getaway Special canisters, one SSIP mid-deck locker experiment and one LDEF experiment package, to date, and I am presently participating in two Getaway Specials and two SSIPs scheduled for flight within the next six months. I am also involved in preliminary negotiations with both NASA and the U.S. Air Force involving future Getaway Special and Hitchhiker flight opportunities for small, free-flying satellites.

My expendable launch vehicle experiences began in 1947 with suborbital flights of V-2 rockets at the White Sands Proving Ground in New Mexico and have continued to the present. Altogether, I have been associated in one way or another with more than five hundred launches of over twenty types of rocket-propelled launch vehicles from sites on six continents, and I am presently negotiating small satellite flight opportunities on expendable vehicles with both NASA and the private sector.

First, I would like to comment on the Getaway Special and Hitchhiker programs. Ever since the beginning of the small, self-contained payload, or Getaway Special program in October of 1976, NASA has consistently striven to simplify its manifesting procedures in order to accomodate the widest possible variety of small-scale users of the Space Transportation System. Over the past eight years, NASA top management has unflaggingly supported the Customer Services Division's and the Goddard Space Flight Center's efforts to improve the program's features so as to keep pace with the steadily increasing sophistication of Getaway Special user requirements.

The original concept of a user-supplied, sealed canister with no electrical connection to the orbiter and no on-orbit crew services of any kind has evolved into today's NASA-supplied canister and astronaut-initiated relay operations inside the canister, at no additional charge and with no price escalation for inflation, plus an extra-cost, optional window and opening lid. Furthermore, during the 51-B mission in January of 1985, a new, full-bore opening lid and payload retention/ejection system will be used for the first time to eject a free-flying satellite from a Getaway Special canister into independent orbit.

The number of experiments carried on each flight has grown from a single canister flown on the starboard sill of STS-4 in June of 1982 to seven canisters on the sills of STS-7 in June of 1983, to a planned 23 canisters to be carried on a combination of sill mounts and an across-the-bay structure early in 1985.

In addition, Getaway Special canisters have been employed to house a variety of other payloads, ranging from a Cinema 360 camera to materials processing experiments on MBB's free-flying SPAS pallet satellite. And now the Hitchhiker program is being offered as a logical outgrowth of the Getaway Special capability. Experiment power, heating, cooling, control and data handling features will be supplied to experiments mounted either on bridge beams or across-the-bay structures. The maximum experiment weight permitted will be increased dramatically.

The NASA field centers have enthusiastically participated in the Getaway Special program evolution. Goddard, as the lead center, has steered the course, with excellent cooperation from the Johnson, Kennedy and Marshall centers. The program has been kept straightforward, simple and responsive. As an example, Utah State University's Getaway Special payload G-518 was integrated into the orbiter less than six weeks from the date the request to fly was sent to the Customer Services Division.

I would now like to comment on the Long Duration Exposure Facility program. Conceived and managed by the Langley Research Center in the mid-seventies, LDEF-1 is circling the earth at the present time, exposing some fifty-seven experiment packages to the space environment for an extended period of time, in a basic study of materials and techniques potentially useful in Space Station construction and operation. The facility was placed in orbit on 6 April 1984 and will be retrieved on or about 18 March 1985. A second LDEF is in the planning stages for launch into a high-latitude orbit in mid 1987 and retrieval two years later.

Here again, NASA Headquarters and the Langley, Johnson and Kennedy field centers adopted a "can do" attitude and have made life extremely simple for LDEF investigators. For example, a package of Morton Thiokol solid rocket propellant, case, liner, insulation and nozzle material samples was mounted on the LDEF structure less than three months after permission to fly was requested of the Customer Services Division.

My third comment is on the Shuttle Student Involvement Project. An adaptation of the 1973-74 Skylab Student Project, this program provides flight opportunities for experiments devised by ten high school students each year. The students are selected by means of a competition conducted for NASA by the National Science Teacher's Association, and a volunteer industry sponsor assists each student in building his or her flight hardware and works with the Johnson center to integrate that hardware into a mid-deck locker.

Once again, NASA Headquarters, Johnson and Kennedy have done everything in their power to simplify the process of designing, building and installing experiments in the orbiter and to provide the selected student with the best possible introduction to space science and engineering. In particular, the crew systems and safety organizations at JSC have bent over backward to solve safety problems rather than to erect barriers to their solution, and members of the astronaut corps have provided enthusiastic support of the program during both the experiment design phase and on-orbit operations.

In summary, NASA has done an outstanding job of making it convenient for small customers to fly experiments aboard the Space Transportation System. In my own experience, it has been no more difficult to design and build experiments for Space Shuttle flights in any one of the three categories listed above than it was to design and build a piggyback chemical release experiment for flight on a Delta launch vehicle in 1978. Similarly enthusiastic cooperation was received on that program, and the amount of documentation required was comparable.

The challenge from this point on will be to maintain the high degree of flexibility and responsiveness to changing user needs that has been evidenced in the past. For example, now that the concept of ejecting a free-flying satellite from a Getaway Special canister has been approved, it will inevitably follow that approval will be sought to test a small propulsion system to adjust that satellite's orbit. Typical Shuttle orbits are far from optimum for the uses envisaged for several small satellites in the planning stages at this time.

A policy for commercial uses of small, ejectable payloads will be required in the near future. The Hitchhiker program will probably be the appropriate home for this type of payload, so long as the Hitchhiker is handled as a "scaled-up Getaway Special" rather than a "scaled-down Spacelab." Discussions relative to a possible range of fees for commercial Hitchhiker ejectable payload services have been under way for some time, and now seems likely that a figure between $100,000 and $150,000 will be settled upon in the fairly near future.

On a final note, Mr. Chairman, "non-scientific" uses of the Space Shuttle, as defined in proposed rule 14 CFR Subpart 1214.16, will require very careful review to insure that the burgeoning "secondary payload" market discussed in today's testimony is not stifled by a lack of flight opportunity. Several generations of high school and university students, and numbers of small, high-tech companies have already obtained extremely valuable training in space experimentation through the Getaway Special, SSIP and LDEF programs. The major emphasis being placed on scientific education by this Administration and this Congress can be enhanced by continuing to keep the door to space research wide open through these three programs.

Thank you once again for the opportunity to testify before you today.

Mr. VOLKMER. Thank you.

We will begin with questioning, and I'll recognize the gentleman from New Mexico.

Mr. LUJAN. Thank you, Mr. Chairman.

I'm just wondering, Mr. Ziegler, your experience in dealing with the French and with NASA, give us a little benefit of your experience in this regard.

Mr. ZIEGLER. Well, I guess the sense of the question is contrast to those—the negotiating experience, if you will, and the initial part of the booking process and the coordination process.

In spite of the fact that we started taking French lessons about the time of contract, there was a language difficulty, and—but most of the French spoke a lot better English than we spoke French, so that most of it was conducted in English.

The other thing that was apparent is that the French did not have any long experience, if any, in negotiating launch service agreements for commercial customers, and—so that was really a new experience for them, and that wasn't all bad for us. We were able to negotiate some better terms and conditions than we would be able to now after they have gotten some experience, and I think our termination provisions, for example, which we did exercise later on, were better than they would offer today to any commercial customer.

The process—of course, there were to be two payloads on the Ariane flight that we were on, a French communications satellite as well as our Westar VI.

The missions were very similar, so we had similar orbital requirements and had not too much difficulty in making the missions compatible.

Mr. LUJAN. They were two different satellites, though?

Mr. ZIEGLER. Two different satellites, yes—the French Telecom IA was scheduled to go, along with Westar VI, yes. One was built by the French, and the other was built by Hughes Aircraft Co.

So that we were—I think our experience with Ariane, to the degree that we carried it through, was very similar to our experiences with Delta and the five launches that we did carry through.

I don't know whether I've answered your question.

Mr. LUJAN. Yeah; yeah.

On using the shuttle, is there any reason why they can't schedule you quicker—the turnaround time—if one is scrubbed, from your perspective?

Mr. ZIEGLER. Well, they—the launch service provision says they'll give you a relaunch or a replacement launch if there's a——

Mr. LUJAN. Yeah, but a long time away, and that's——

Mr. ZIEGLER. No. Well, they say within 9 months of the time that you request or such date as——

Mr. LUJAN. You mean NASA?

Mr. ZIEGLER. NASA would; yes.

Mr. LUJAN. Yeah.

Mr. ZIEGLER. NASA has—that—by the way, that provision is, I guess, being tested right at the moment. NASA has interpreted that provision that they would give a—Western Union a replacement launch and would upset any NASA payload that is—give us priority over any NASA payload, but—and would try to persuade other customers to take a later date so that we could get an earlier date.

Mr. LUJAN. What do the other——

Mr. ZIEGLER. But that didn't get us as early a date for our next launch as we would like.

Mr. LUJAN. Yeah. One of the things, you know, we—of course, I look at accommodating the commercial customers but—in replacing NASA experiments. The basic mission of the shuttle is research.

Mr. ZIEGLER. Hm-mm.

Mr. LUJAN. And if the replacement could be that it doesn't seriously damage NASA's mission as a research organization, well, it's not very easy to make all of those—to put everything where each side comes out.

Mr. Lyons, you also have experience with the French.

Mr. LYONS. It's fairly recent experience and certainly isn't extensive.

We have had a team go down to Kourou to look at the launch site. We've gone to the negotiations, signed a contract, we've discussed our mission in some detail at this time, but we're not really far along in the process.

Mr. LUJAN. Are they more accommodating? That's really what I want to get at. Are they more accommodating than NASA, or less, or still——

Mr. LYONS. I think the only distinction I'd make would be—have to do with flexibility in pricing, which is, a real inhibition that NASA has. They are unable, really, to respond to what is fundamentally a competitive market.

Mr. LUJAN. You mean haggling over the price of—what are you——

Mr. LYONS. The ability——

Mr. LUJAN. Negotiating, I should say.

Mr. LYONS. Negotiation—prices, yes, that's correct. I mean Ariane perceives themselves, I think, as somebody in competition and is very much interested in offering a price that will win in that competitive environment, and I think NASA—the personnel I talked to, would like to offer the same advantages, but they're inhibited by the Government structures in which they operate.

Mr. LUJAN. And NASA is kind of like if you walk into Woodward & Lothrop and say, "This is the price."

Mr. LYONS. That's it, and I think you know that they've done some things to—there was a block-buy offer on Intelsat that they attempted—to put more attraction into their pricing in order to compete with Ariane, but they are fundamentally inhibited.

Mr. VOLKMER. The gentleman from Florida.

Mr. MACKAY. Mr. Lyons, on page 5 of your testimony, you indicated your company's reasons for contracting with Arianespace. It seems to me that you are saying that there's no assurance that NASA will have a backup ELV capability over a long period of time and that if NASA runs into an unexplained problem with one of its vehicles, it might, because of crew safety concerns, have to ground the whole fleet for a long period of time. So you felt that you needed to, in effect, learn how to also deal with the competition out of conservative business practices.

Mr. LYONS. That's correct.

Mr. MACKAY. Would you have made this decision if NASA had been able to assure you that it would continue to have a backup ELV capability?

Mr. LYONS. I think we would have very logically gone along with, our experience with Delta. It's been a very good experience we've had so far. Our logical path would have followed along with the Delta vehicle being available. So we made our decision predicated on certainly uncertainty about the availability of that vehicle.

Mr. MACKAY. I'd like to ask the other witnesses that same question. Is the apparent lack of long-term commitment on NASA's part to having an ELV backup capability a source of concern and is it a factor that is, in effect, driving you to have to establish other relationships?

Mr. ALMOND. On behalf of Telesat, we did make a down payment on an Ariane launch at the time of the development firings of the shuttle. However, we didn't exercise that option, because the shuttle seemed to have solved its problems, and we had two successful launches. But we have been under great pressure from Ariane to take up one—that option and had very attractive financing offered.

Mr. MACKAY. So the primary—from your standpoint, the primary consideration would be a legitimate concern over pricing and financing?

Mr. ALMOND. Yes. Our situation is a little bit different. We have two more satellites that we're going to launch this year, and then we'll be in a period of no launches for 3 years, or maybe 4, so that we feel that spending money in order to make a reservation in that period isn't necessary, and in fact we have ordered five launches on the shuttle from 1988 to 1995.

Mr. MACKAY. All right.

Mr. Ziegler, I'd like your comments. You've apparently had equally bad results with both. So I guess you're now—maybe it was just that there was some divine prohibition against that.

Mr. ZIEGLER. It is true that we have had concerns about the schedule assurance that the shuttle can offer because it is a manned vehicle, and that there could be safety-related problems which could shut down the fleet for a year or two.

I think the primary factor—the primary reason that we went to Ariane was the economics of the situation compared to Delta and the schedule assurance compared to the shuttle.

We—as far as the future is concerned, I think probably it's going to—economics is probably going to play the biggest part in our decisions, but schedule is very important to us.

When we have—well, satellite—by the time it's launched, it's in the area of a $100 million investment, and if that should sit around a year before—before we can get it in the air, you know, that's increased—whatever the interest rate is on $100 million, it's an increased—increases the investment, and it's even worse than that, because that satellite is not earning revenue. Hopefully, it's a lot higher rate——

Mr. MACKAY. You have lost revenue, and you paid interest.

Mr. ZIEGLER. So we like the idea that there will be several competitive options for launches.

Ariane was able to offer us a launch in about a 2-year lead time from the date of contract to the date they were scheduled to launch us, and NASA was able to—NASA shuttle was able to turn around and give us—actually give us a launch within 10 months of the date we reached agreement with them, so that there appears to be flexibility on all parties' parts to keep the competition going.

Mr. MacKay. Thank you, Mr. Chairman.

Mr. Volkmer. The gentleman from California.

Mr. Brown. Of the four of you who are involved in launching satellites, I get the impression—maybe it's incorrectly—that you might feel a little more comfortable if you had a continued, reliable, dependable Delta launch vehicle that might end up meeting your needs in terms of turnaround time, and so on, better than the shuttle under the present circumstances, and I presume that conceivably it could even be less cost, of course depending a little bit upon somewhat artificial pricing policies set on the shuttle.

Does that reflect your views? Am I misinterpreting what you are saying?

Mr. Ziegler. Let me give that a shot first. I think Western Union would much prefer to go on a Delta launch vehicle if other things were equal, such as the price. We don't really care about the cost, as long as the price was the same. We'd much prefer to go on the Delta.

Mr. MacKay. Except that you pay taxes.

Mr. Ziegler. As a taxpayer, yes.

Mr. Brown. I assume that the Delta cost and Delta price are coming somewhat into equilibrium, because of a simpler and stable system. That is, I assume we have just about run out the learning curve on the production and operation of the Delta, so there aren't any major cost savings, and assuming that it isn't subsidized, why, you have a fairly stable cost or price situation.

The situation on the shuttle is entirely dependent upon somewhat arbitrary decisions made as to how to allocate the R&D costs.

I don't know how you would account for the actual operating costs. I presume some smart accountant could distribute them in some reasonable way, but you can never account in a satisfactory way for the R&D costs at this stage, I don't think, because it's still in R&D actually.

How do the rest of you feel about that?

Mr. Lyons. I'm on record. I would like to have an alternative launch vehicle always available. Frankly, I think SBS has a fundamental preference for the shuttle as a launch vehicle, but the contingency situation necessitates some alternative available.

Mr. Brown. And you don't care whether it were operated commercially or by NASA as a backup to the shuttle, I suppose?

Mr. Lyons. No; that's not a significant factor.

Mr. Almond. I think Telesat also would like to see a continued ELV available just in case of a catastrophic failure that might hold up launches of the shuttle for a prolonged period of time.

I think if the price was the same, there's less anxiety in launching on an expendable launch vehicle, because you can pick up your satellite about an hour and a half after launch, and you'd know whether it's healthy. With the shuttle, it may be anywhere from 3 days or 4 days, and you have that nervous period you have to live through.

Mr. **Moore**. And we've found in the case of the Delta, it has more of a history of polar launches and for the sorts of satellites that the groups that I'm associating with are concerned—polar, at about 500 kilometers altitude or higher, is a much better orbit for the kinds of satellites that we wish to fly, and to that extent, the Delta is more desirable.

There are few shuttle flights coming up soon to polar orbit, especially to those altitudes.

Now, if we're allowed to test an additional propulsion system—a small additional propulsion system to help us achieve those additional orbits from 57° latitude flights—or inclination flights, and get on to those altitudes, then I—the shuttle is fine. The Delta's attraction to my associates is just that of polar orbit and a little higher altitude.

And of course NASA is not abandoning the Delta Program. NASA has negotiated an agreement with a private organization to offer Delta launch vehicle services provided that that organization can find sufficient commercial customers to—just three—who make it come about. There will be a Delta, provided that there is a market for the Delta.

Mr. **Brown**. Well, I tend to feel that all of this is within a framework that's highly transitory—that is, that we're in a transitional period here, and we ought to recognize that and not be committing ourselves to ultimate decisions for systems that won't be in their fully mature stage for some period of years yet.

That was the end of my time, I suppose. I ask unanimous consent to proceed for 2 additional minutes.

Mr. **Volkmer**. Without objection.

Mr. **Brown**. Now that represents one kind of a market—the launch of communications satellites. That's a fairly firm market. I don't know what the estimates are, but I would guess we would be able to count on several per year ad infinitum, or on into the indefinite future, because of the needs for replacement of a saturated orbital system.

I'm intrigued, Mr. Moore, by your view that we—that the shuttle is more appropriate to the kind of scientific experiments that you have been involved in, or to those kinds of things that require longer duration in orbit or require manned accompaniment. The shuttle is unique in servicing that market. That's correct, isn't it?

Mr. **Moore**. Yes, sir; obviously, there is no other way to do it, if you can't get them back.

Mr. **Brown**. So part of the problem is that we've really been, to some degree, starving our scientific program in space for a number of years as we spent most of our resources on shuttle development and other kinds of things, so that in a situation where we were to regain a more robust scientific posture in space, it might, in turn, resolve some of the problems with regard to the shuttle that stem from, we'll say, temporary overcapacity and a threat of losing some precious customers.

Mr. **Moore**. Yes, sir; but funding of those scientific payloads must accompany the availability of the space into which to put them, and as you accurately portrayed the fact, we have not had an adequate funding of the space science programs of this country for some time, and let's hope that that returns.

Mr. BROWN. One of our great national laboratories, JPL, has practically gone out of business because of that, but that may again change in the future, and of course the funding arrangements are somewhat more flexible, because the scientific experiments may be funded from other sources from NASA. There may be NSF or Department of Energy, or God knows what all could be funding them.

Mr. MOORE. Or for the sorts of payloads that Microgravity Research Associates are planning by the commercial sector.

Until the private dollar enters the space program in a big way, the space program will never flower to its full capability.

Mr. BROWN. So we need to continue to look to the further encouragement of the private sector participation in space research.

Mr. MOORE. Precisely.

Mr. BROWN. And make it easier for them to do that.

Thank you, Mr. Chairman.

Mr. VOLKMER. That's quite all right.

Just a moment. It looks like we're going to have a vote, and I'll try——

Mr. BROWN. Well, you can have 7 minutes.

Mr. VOLKMER [continuing]. Some questions real fast.

I'd like for Mr. Almond and Mr. Lyons to comment as to whether or not—in reviewing your statement and your testimony—as to the problems that you had in integrating your payload with the shuttle, the timeframe, and the security, and all that—comment as to whether or not you feel that NASA has been cooperative in trying to reduce the amount of paperwork and the timeframe.

Mr. ALMOND. Yes; I think there's been—there's been great improvement since the first one, of course, because we were very—all of us, I guess, NASA included, were just starting the learning curve.

I think in the future, though, for the shuttle to be useful for communications satellite use, there has to be some more uniform way you can get your payload on board the shuttle in some period like 4 or 5 weeks rather than the 13 weeks that's now——

Mr. VOLKMER. In other words, so that the shuttle—you won't have to have your satellite or your payload available such a long period of time, plus processing time. Do you agree with that, Mr. Lyons?

Mr. LYONS. Yes; I do. Mr. Almond and I suffered through that first operational launch, which was a 17-week phase at the Cape for our payload. So as I indicated, we are now down to 13 weeks on this mission. We'd like to get it down further. We would like to reduce and standardize the paperwork so that there is a minimum number of meetings needed to discuss these things with NASA.

They are working at it; no question about it. They've contacted, I'm sure, Mr. Almond as well as myself, asking how they can help, and we're seeing the progress, because they are sensitive to the problem.

Mr. VOLKMER. Mr. Ziegler, have you started in anything yet on your December, 1985, launch with NASA as far as——

Mr. ZIEGLER. Well, have an agreement, a launch service agreement. Our spacecraft is under contract; our PAM is under contract.

Mr. **Volkmer**. When are you to deliver——

Mr. **Ziegler**. The next major event—oh, we are to deliver—well, we'll be ready to deliver the spacecraft to the Cape by June 15 for the December scheduled launch.

Mr. **Volkmer**. So really, there's no problem there, as far as you're concerned?

Mr. **Ziegler**. No, but we agree that the tie-up time, where you have virtually no visibility as to your spacecraft, is too long, and we are expecting it to come down.

When we were scheduled for a November launch, we were talking about a delivery to the VPF; that's where—that's the point where we lose access, really, to our satellites—of August 8, and that's a fairly long period of time, from August 8 to November—I think it was November 23, is still a long period of time.

Mr. **Volkmer**. What about on the Ariane, Mr. Lyons? How much timeframe do they require?

Mr. **Lyons**. They would require approximately 5 weeks. We expect, because it will be our first mission with them, we'll probably be down there at least a week earlier than that, a 6-week total duration, in Kourou.

Mr. **Volkmer**. So that would compare basically what you were familiar with with the Delta?

Mr. **Lyons**. That's correct.

Mr. **Volkmer**. We—as I understand it, we presently have five Deltas that have been completed and maybe TCI or somebody may purchase those. Are you all interested? Have you all been contacted by those people?—without going into any, you know, specifics on negotiations. I just want to know if you all have been contacted.

Mr. **Lyons**. Yes. They were considered in our decision to select Ariane as our expendable launch vehicle.

Mr. **Volkmer**. All right. And the Ariane, as you've testified, the basic reason for it—as I understand from your testimony—was the monetary situation—the cost-plus financing and everything?

Mr. **Ziegler**. True for Western Union. I don't know about the other——

Mr. **Lyons**. In our particular case, we were faced with good prices from both TCI and Ariane. However, the Ariane price was a firm fixed price, and the TCI price was contingent upon two additional sales that would permit them to go—formally into business.

Mr. **Volkmer**. Right.

Mr. **Lyons**. We had guarantees of a launch—NASA would launch us if TCI didn't make it—but the price from NASA was not directly competitive with the price that we could obtain from Ariane.

Mr. **Volkmer**. All right.

Mr. Ziegler, I'd just like to know if you've reached any conclusion yet, without stating what it is, at this time—any conclusion whether you're planning to retrieve Westar VI.

Mr. **Ziegler**. That hasn't concluded yet. The last word I had on that, all the lawyers are negotiating with underwriters' lawyers.

Mr. **Volkmer**. So there's no——

Mr. **Ziegler**. There's no definitive decision as of a few days ago.

Western Union is willing to give all its rights in that satellite to all of the underwriters, but since there are several hundred underwriters involved, all of which have some rights, that's a hard job to do, and it takes some lawyers—a lot of attention by some lawyers.

I think they were pretty close the last time I looked at it, but nothing definitive yet.

Mr. **Volkmer**. All right.

Now, Mr. Ziegler, you've addressed, and I think Mr. Almond, perhaps to some extent, the problem of the upper stages and reliability, et cetera, and whether or not there should be a possible certification process for these upper stages, like PAM and the rest of them.

Do you think that this is consistent with our present efforts to commercialize, here in the United States, the space program?

Mr. **Ziegler**. I'm not sure whether it's consistent or not, but I think it's necessary. If we're going to have successful commercialization, it will be necessary to have some sort of an oversight—independent oversight.

Mr. **Volkmer**. Are we talking about an inspection system? Are we talking about each individual upper stage, or are we talking about a general overall certification of a process for an upper stage?

Mr. **Ziegler**. Well, I think it's a process—both. It's very similar to what Goddard Space Flight Center has done earlier with the Delta under, well, Mr. Moseson, who has now retired, and I think the committee is now headed up by Alton Jones. But they have maintained a small group of people—half a dozen or so—who would continually look at all the contractors and subcontractors involved and keep up to date on events, manufacturing changes, and review them, and would come to the flight readiness reviews, chair the flight readiness reviews, and sign off on flight readiness, and that was very comforting, and I—particularly in Westars IV and V. I felt that loss very dearly—that we didn't have that for the commercialized PAM.

We made that observation to NASA in at least two forums.

Mr. **Volkmer**. You think the expense of this should be borne by the Government—by the taxpayers? Or should the expense be borne by the manufacturers of those upper stages?

Mr. **Ziegler**. I think it would be satisfactory either way.

Mr. **Volkmer**. As a user——

Mr. **Ziegler**. It's necessary, and if I have to pay for it, why, I think we'd be ready to pay for it.

Mr. **Volkmer**. You mean if the manufacturer is going to pay for it, ultimately he's going to try and pass it on to the user?

Mr. **Ziegler**. Absolutely.

Mr. **Volkmer**. But even he'd be willing to do it because of the reliability there.

Let's assume, though, that NASA then, or any other Government agency, would be the one certifying, and then we have a failure. Is the U.S. Government then the person who's liable?

Mr. **Ziegler**. No, I wouldn't think so.

Mr. **Volkmer**. You'd be willing to, as a user, agree that the United States would not be liable?

Mr. **Ziegler**. We will still buy insurance——

Mr. **Volkmer**. Right.

Mr. **Ziegler** [continuing]. As long as it's available.

Mr. VOLKMER. Anyone else wish to comment on that?

Mr. LYONS. I really don't agree with Mr. Ziegler, in that when we fly satellite, we have two stages. There is a PAM upper stage, such as we had; and then we have an apogee motor, which is built into the satellite.

Traditionally, I, as a customer, and my manufacturers have been responsible for that final upper stage. I don't perceive the situation much different.

If I'd had my druthers at the start of the program, I would have preferred for the PAM to be part of the NASA contract, and we did recommend that to them.

Mr. VOLKMER. Yes.

Mr. LYONS. Simply for an awful lot of standardization of interfaces, the singleness of dealing with a contractor, et cetera; those were desirable properties.

But I think that our normal way of doing aerospace business accommodates these considerations. It has in the past with the apogee motor and can accommodate any concerns on reliability with perigee motor.

Mr. VOLKMER. I'm going to have to quit, because we do have a vote coming on. I have very few questions left. What I'd like to do—I have a question I'd like to direct to Mr. Pace, a couple of them—and I'll submit them to you in writing and appreciate if you would reply to them, so that we can get them in the record. They basically will pertain to your discussions with NASA on the JEA and whether you're endeavoring to look forward to using free-flyers, et cetera, and how that fits in.

Mr. Moore, I'd like to address a question to you pertaining to NASA's improvement in both the Hitchhiker Program and the others, and how that seems to be improving, and what recommendations you might make for continued improvements in that.

Mr. MOORE. Thank you, sir.

Mr. VOLKMER. The last ones I'll address to the other three, and that is on the pricing mechanism, and get into that, as to what recommendations you may specifically make in regard to this 3-year pricing, or should it be 1 year, 6 months, or what it should be, and we would like to have that.

With that, I'm going to have to conclude, and thank you very much for being here today.

Mr. LYONS. Thank you, Mr. Chairman.

[Whereupon, at 12:25 p.m., the subcommittee adjourned.]

[Answers to written questions for Mr. Almond, Mr. Lyons, Mr. Ziegler, Mr. Pace, and Mr. Moore follow:]

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

HEARING TO REVIEW SPACE SHUTTLE REQUIREMENTS, OPERATIONS, AND FUTURE PLANS

2 August 1984

Additional Questions for John Almond

ANSWER TO QUESTION No. 1

For commercial communication satellite systems the Space Shuttle Pricing Policy resulting in the lowest overall launch cost to geosynchronous orbit is preferred, i.e., a policy re. recoup of only additive shuttle costs. Alternative shuttle pricing policies that are not competitive with available expendable launch vehicle (ELV) systems, would result in selection of the ELV mode. It is our major concern that the cost of both STS and ELV launches remains reasonably low, otherwise some applications of communication satellite systems will not be commercially viable.

ANSWER TO QUESTION No. 2

Frequent smaller changes in shuttle pricing would generate a smoother price vs. time curve than the major step changes of the current policy. This would be of particular value when planning, or rescheduling, dictate the need for a launch just into a new pricing period. Also, the elimination of major pricing changes would establish the credibility of long term shuttle launch cost estimates.

It is, however, essential that commercial users of launch vehicles know many years in advance what launch costs will be (excluding inflation), as commitments are made to customers well in advance of the service date. A beneficial alternative would be for the basic shuttle prices to be set each year, and NASA to allow those prices to hold for all launches, or options, formally committed to in that year, irrespective of when the launch will occur, and allow an inflation factor to be used depending on the actual date of launch.

ANSWER TO QUESTION No. 3

Priority Ranking in Shuttle Operations:

1. Pricing
2. Maintaining the scheduled launch date
3. Integration time
4. Complex processing operations and paperwork
5. Conflicts because of multiple payloads
6. Inflight checkout

ANSWER TO QUESTION No. 4

Willingness to Pay and Importance of Following Features:

(i) Manned involvement: Not important, prefer automated systems.

(ii) Recovery & Repair: Not important, do not anticipate requiring this feature for a commercial geosynchronous system.

(iii) Last minute "No": Minimal importance, ground support system should be reliable and redundant. Spacecraft designed and pre-tested to withstand launch and operate with redundancy.

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
SPACE SHUTTLE HEARINGS

REPLY TO ADDITIONAL QUESTIONS

Michael T. Lyons
Vice President and General Manager
Space Segment Engineering and Operations
Satellite Business Systems

Question 1: Could you please state for the record your views on Space Shuttle pricing policy (e.g., Should it be based on recouping only "additive" cost vs. "total average" cost? What would the impact of alternative pricing policies be on the economic viability of your firm's current and planned space ventures? To what degree would the alternative pricing policies affect the extent to which your firm uses the Space Shuttle?).

Answer The Space Shuttle is an instrument of national policy, designed primarily for scientific and military missions. These operational requirements build into a Shuttle launch substantial additional costs and complexity not required simply to launch a communications satellite. A pricing policy that attempts to have satellite carriers absorb a portion of the costs associated with the full range of the Shuttle's operational requirements runs the risk of precipitously increasing the Shuttle's price and foreclosing the Shuttle from vigorous competition for launch services. Price is obviously a major consideration in selecting a launch vehicle, and alternative policies that sharply increase the cost of a Shuttle launch could decrease its use. Such a result would be to the ultimate detriment of the Shuttle program itself and the taxpayer.

A sound pricing policy would attempt to maximize use of the Shuttle. Maximum Shuttle use brings a double benefit. Payments from commercial users help offset a portion of the cost of the program, and the accumulation of flight experience increases operational efficiency and decreases costs, making the Shuttle even more attractive in the future.

Question 2: It was suggested by Mr. Ziegler that the Space Shuttle price changes should be frequent and small vs. infrequent and large. Do you agree? What would be a reasonable frequency for the prices to change. (NOTE: NASA now uses a three-year pricing period.)

Answer Predictable and reasonable evolution of pricing is important to planning a satellite launch. Because of the long-lead times for communications satellite launches, substantial advance notice is also desirable. Smaller pricing increments established well in advance would be helpful. I cannot specify a precise frequency.

Question 3: How would you rank the relative priority of the various factors in Shuttle operations: a) Maintaining the scheduled launch date; b) Conflicts because of multiple payloads; c) Complex processing operations and paperwork; d) Pricing; e) Integration time and f) Inflight check-out.

Answer Because a decision to launch on the Shuttle is influenced by a variety of elements, these factors are not susceptible to a precise ranking. Price and schedule are two of the most important factors, and integration time is also a significant consideration. Multiple payloads, processing operations, and inflight check-out are not insignificant but relatively less important.

Question 4: How important to you are such features as manned involvement, the potential for recovery and repair, and the last minute "NO", and would you be willing to pay extra for them?

Answer Last minute "NO" is of definite value, and can potentially reduce disruption to customer service and loss to the underwriter. Manned involvement is not of major benefit for the SBS type mission. Potential for repair and recovery is not significant for this generation of satellites.

RESPONSES TO ADDITIONAL QUESTIONS FOR
F. WILLIAM ZIEGLER

QUESTION 1

Could you please state for the record your views on Space Shuttle pricing policy (e.g., Should it be based on recouping only "additive" cost vs. "total average" cost? What would the impact of alternative pricing policies be on the economic viability of your firm's current and planned space ventures? To what degree would the alternative pricing policies affect the extent to which your firm uses the Space Shuttle?).

RESPONSE 1

Since Western Union is in the very competitive business of providing communication services, it is vitally interested in providing transmission facilities for those services at the least possible cost. At any time that we are faced with the procurement and launch of one or more satellites, we will undoubtedly "shop" to get the best deal possible. Necessarily we must consider other forms of transmission such as cable, microwave, or fiber optics in the event satellite transmission costs would place us in a non-competitive position.

The current cost of launching a communications satellite to geosynchronous transfer orbit is about one-quarter to one-third of the total cost of satellite construction, launch and initial operation in geosynchronous orbit. A modest increase in the cost of launch services would not have a significant impact on our decision to launch satellites providing (i) all of our competitors were faced with similar price increases, and (ii) launch insurance is still available in adequate amounts.

If the Space Shuttle should adopt a pricing policy based upon recouping "total average" cost, I would expect that all of the commercial entities would select another launch vehicle (i.e., Ariane or a commercialized expendable) because of the price advantage. In other words, Shuttle would be out of the competition. On the other hand if the Space Shuttle should adopt a pricing policy based upon recouping "additive" costs, I would expect that Shuttle would attract most U.S. commercial entities and a good portion of foreign entities planning to launch satellites. Such a pricing policy would deter the commercialized expendable launch endeavors since they would be unable to compete.

Obviously the right pricing policy (if there is one) lies somewhere between the two extremes.

QUESTION 2

You suggested that the Space Shuttle price changes should be frequent and small vs. infrequent and large.

-- What would be a reasonable frequency for the prices to change. (NOTE: NASA now uses a three-year pricing period.)

RESPONSE 2

Since NASA's normal payment plan starts thirty-three months in advance of launch, it is appropriate for the pricing formulas to be established three years in advance of the launch date. I would recommend that each determination be effective for a one year launch period with an annual redetermination for succeeding years.

QUESTION 3

How would you rank the relative priority of the various factors in shuttle operations:

a. Maintaining the scheduled launch date
b. Conflicts because of multiple payloads
c. Complex operations and paperwork
d. Pricing
e. Integration time
f. Inflight check-out

REPONSE 3

In terms of selecting a launch vehicle I would rank these items as follows (however, please see the comments below):

(i) d. Pricing
(ii) a. Maintaining the scheduled launch date
(iii) e. Integration time
(iv) c. Complex operations and paperwork
(v) b. Conflicts because of multiple payloads
(vi) f. Inflight check-out

Clearly pricing and schedule confidence are at the top of the list but which is more important is a close call. For example, for the launch of Westar VI, Western Union chose Ariane over Delta because of a substantial price difference in

RESPONSE 3 (continued)

spite of the significant advantage Delta presented in terms of schedule confidence. Also, we initially chose Ariane over Shuttle because of an (apparent) advantage in schedule confidence in spite of the price advantage offered by Shuttle.About one year later, we chose to switch from Ariane to Shuttle because of a changed picture in regard to schedule confidence in spite of a modest economic penalty.

Integration time is clearly third in priority since it lengthens schedule and, more importantly, exposes the spacecraft to a ground enviornment (people and contamination hazards) for an extended period of time with very limited health monitoring capability.

I have rated inflight check-out last because (i) the degree to which a spacecraft can be checked in its launch configuration is quite limited, and (ii) the only option available is to return the spacecraft to earth which, under the current provisions of the launch service agreement, imposes severe economic and schedule penalties. If better terms for relaunch could be offered, I would increase the priority rating for this feature.

I would like to comment on one other parameter not mentioned in this question. That is, the probability that the mission will be successful. In selecting a launch vehicle, this would seem to be a most important parameter, but our experience indicates that differences in this probability among the various luanch vehicles are relatively small and, further, can only be evaluated in a subjective manner. The end result is that this parameter is not very important as long as launch insurance can be purchased in adequate amounts (and for a reasonable premium).

QUESTION 4

How important to you are such features as manned involvement, the potential for recovery and repair, and the last minute "No", and would you be willing to pay extra for them?

RESPONSE 4

Manned involvement in launches of communications satellites has pros and cons. On balance, I believe it is not an attractive feature for our missions.

RESPONSE 4 (continued)

The potential for recovery and repair for geosynchronous satellites is not, as yet, even on the drawing board. Even in the case of the Westar VI and Palapa B-2 failures, which left them in a low earth orbit compatible with recovery by the Shuttle, it is not abundantly clear that the costs of retrieval, refurbishment and relaunch (when coupled with the associated risks) would make that a viable proposition.

The last minute "No" is also of little value under the current terms for relaunch. My testimony provides more details on this point.

In summary, these features of the Space Shuttle provide little advantage for an entity intending to launch a satellite into geosynchronous orbit and these features would not motivate us to pay a higher price or accept a softer schedule.

FWZ-31/4:mb

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

HEARING TO REVIEW SPACE SHUTTLE REQUIREMENTS OPERATIONS, AND FUTURE PLANS

August 2, 1984

ANSWERS TO THE ADDITIONAL QUESTIONS FOR Robert E. Pace

Question #1. We understand that it took NASA three years to process its Joint Endeavor Agreement with Microgravity Research Associates. Could you comment on your firm's experience in negotiating this agreement with NASA?

Answer: After NASA announced the opportunity to participate in joint endeavors, MRA was the first company to request a Joint Endeavor Agreement (JEA). Since it was the first JEA there was a learning process involved. Many issues arose that had not been identified earlier, requiring NASA to develop a position on each one. Additionally, MRA was a new company formed specifically for commercial activities in space, without a performance record. Because of this, NASA was concerned and had to ascertain that MRA was sincere, had a viable process, had the necessary resources, and was committed to the endeavor. We have discussed our experience with the JEA with NASA management, and are pleased that NASA has a goal of 90 days to process a typical Joint Endeavor Agreement. It should be added that after the JEA was signed on April 11, 1983, NASA assigned the implementation of their part of the Joint Endeavor to the George C. Marshall Space Flight Center, where NASA's part of the agreement has been fulfilled in an outstanding manner.

Question #2. NASA has stated that its goal is to reduce the time required to process a typical Joint Endeavor Agreement to about 90 days. Do you have any suggestions that might help NASA in achieving its goal?

Answer: As stated before, MRA has discussed with NASA the long time it took to negotiate the JEA, and we are quite pleased to hear about the goal of 90 days for a typical JEA. We believe it would help considerably if there was a single central office responsible for interfacing with commercial firms. The senior staff of the office should have experience in the business world. The number of organizational elements that must participate, review, concur, or approve a JEA should be reviewed for reduction. A review for legal requirements, scientific or technical merit, and STS compatibility should suffice. Review beyond that appears superfluous.

Question #3. Could you please state for the record your views on Space Shuttle pricing policy (e.g., Should it be based on recouping only "additive" cost vs. "total average" cost? What would the impact of alternative pricing policies be on the economic viability of your firm's current and planned space ventures? To what degree would the alternative pricing policies affect the extent to which your firm uses the Space Shuttle?)

Answer: It is difficult to comment on the Shuttle pricing policy since there are influencing factors which I am not qualified to address. International competition, national policy on promoting the development of commercial ventures in space, and whether the STS is considered a national resource are some of the factors to be considered. Mr. Anders pointed out in his statement that every mode of transportation we use today is subsidized one way or another by the government. For a small entrepreneurial company, like MRA, opening the frontier of space is a major undertaking, involving high cost, high technology and high risk, with a long term for return on investment. MRA believes it can pay the charges established by the pricing policy and make a reasonable return on investment. However, as I stated earlier, the pricing policy could inhibit the market for the space product. Space transportation is the predominant cost factor. MRA is convinced that the market will expand as the price for the product is reduced, therefore we look forward to lower Shuttle use costs so our space grown semiconductor material will have a wider application. Most airlines have two classes of fares, and sometimes three classes on international flights. There may be justification for more than one rate for the use of the Shuttle.

The Space Transportation System is necessary to open the frontiers of space. Many payloads, like the crystal growth system by MRA, can only use the Shuttle. On the early MRA missions the system will remain on the Shuttle for the crystal growth period. When a free-flyer, or the space station becomes available the system will be located there with the Shuttle used to transport the system initially, and for resupply and return of the products. The pricing policy will affect the extent of use since it will influence the market. As I mentioned earlier, we suggest the pricing policy include a system of deferred payments. Most business arrangements of this nature do not require advance payment. Deferred payment would assist in that period between the completion of the Joint Endeavor and the marketing of the product from the first commercial flights.

Question #4.

It was suggested by Mr. Ziegler that the Space Shuttle price changes should be frequent and small vs. infrequent and large.

-- Do you agree?

-- What would be a reasonable frequency for the prices to change. (NOTE: NASA now uses a three-year pricing period.)

Answer: The three year pricing period currently used by NASA seems reasonable. It provides a three year period of stability for business planning. It would be most helpful if NASA would provide pricing forecasts for the out years. Many space commercialization projects require financial planning of ten to fifteen years. This is difficult to do without some forecast from NASA on the future costs.

Question #5.

How would you rank the relative priority of the various factors in shuttle operations:

a. Maintaining the scheduled launch date
b. Conflicts because of multiple payloads
c. Complex processing operations and paperwork
d. Pricing
e. Integration time
f. Inflight check-out.

Answer: It is my understanding that the question is asking which of the six items are more important to MRA as a Shuttle user. Item d. Pricing, is the most important to MRA. Next are Item c. Complex processing operations and paperwork, and Item e. Integration time, because they add to NASA costs and affect pricing, and they add to the cost for the payload developer. Item a. Maintaining the scheduled launch date is important if there are delays of a long time (weeks) for the reasons stated above. The MRA payload will not be sensitive to launch date or time. We do not expect a problem with Item b. Conflicts because of multiple payloads. Item f. Inflight check-out will be a routine part of the payload operation and not an issue.

Question #6.

How important to you are such features as manned involvement, the potential for recovery and repair, and the last minute "NO", and would you be willing to pay extra for them?

Answer: We are aware of the proven benefits of the presence of man in space and plan to take advantage of his presence where it is beneficial to our process. The planned use will include routine operations and troubleshooting.

Our payload will be essentially dormant at launch, therefore we do not anticipate the need to exercise a last minute "NO". Also, we expect to be part of a multiple payload which must be considered in saying "NO".

It is appropriate for the pricing policy to include as an optional service, use of the on board crew, and for the result of causing a launch scrub at the last minute.

APPENDIX

MORTON THIOKOL, INC.
Wasatch Division

22 August 1984
G030/RGM-85-037

Harold L. Volkmer, Chairman
Subcommittee on Space Science
  and Applications
Committee on Science and Technology
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

In reply to the questions posed in your letter of August 9, 1984, I am pleased to supply the following answers:

1. The Hitchhiker program fills a wide gap in capability between the Getaway Special and the present minimum formal accomodation offered by NASA. First of all it affords the Spacelab investigator an excellent opportunity to follow up an exciting discovery made on a Spacelab flight with a quick test on a Hitchhiker of a new instrumental concept or a new theory, and then to plug the results into a subsequent all-up multi-user Spacelab flight, after a minimum investment of time and money. This is the so-called "scaled-down Spacelab" version of the Hitchhiker.

   There is an altogether different type of use of the Hitchhiker, which I've called the "scaled up Getaway Special," in which a small company, university, individual investigator or group of undergraduates, having gotten a little pregnant with a Getaway Special experiment, now wishes to move up in the world in terms of control system complexity or total data recording capacity or maximum weight allowable, for example.

   The first class of Hitchhiker user is totally familiar with and capable of handling Spacelab-type documentation and integration complexity (although he certainly doesn't enjoy it). The second class of user would be completely destroyed by the Spacelab style of doing business. He has neither the technical sophistication nor the economic resources to play in the Spacelab league.

   The Hitchhiker program must be configured to accomodate this second class of user. Otherwise a significant body of research and a large number of fledgling commercial space manufacturing companies will die aborning.

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2. Space Shuttle pricing policy should be based on recovery of additive cost only. The past, present and future economic, technologic and emotional impacts of the space program on the United States of America are so profound that it is inappropriate for the users of the Space Transportation System to shoulder its entire burden. Unless attractive prices are offered for Shuttle flights of progressively more complex commercial ventures, the space entrepreneur just will not be able to develop the backing he requires as the time for scaleup approaches.

3. I agree with Mr. Ziegler that price changes should be smaller and more frequent. This is the classic approach taken by public utilities, and, after all, what else is the Space Shuttle? Annual revisions to the pricing policy are probably achievable and digestible.

4. I would restate the priorities of the various factors in Shuttle operations as follows:

   a. Pricing
   b. Complex processing operations and paperwork
   c. Pricing
   d. Complex processing operations and paperwork
   e. Pricing
   f. Complex processing operations and paperwork

5. Manned involvement and the potential for recovery and repair are the major features that distinguish the Shuttle from the expendable vehicle, and it's obvious that one must be willing to pay extra for them; otherwise, he might just as well use the expendable. I don't understand the "last minute 'No'." That's a feature designed into any launch vehicle. Why should it cost extra?

Thank you, Mr. Chairman, for the opportunity to present testimony before your committee and to respond to your additional questions. It was a pleasure.

Sincerely,

Gil Moore

R. Gilbert Moore
Special Projects Manager
Space Programs

RGM/kk

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

Reply to Attn of

September 14, 1984

Honorable Harold L. Volkmer
Chairman, Subcommitee on Space
 Science and Applications
U.S. House of Representatives
Washington, DC   20515

Dear Mr. Chairman:

I was pleased to substitute for Chairman John C. Brizendine in presenting the views of NASA's Aerospace Safety Advisory Panel at the Subcommittee's hearing on August 2, 1984, to review Space Shuttle requirements, operations, and future plans. In reviewing the transcript of the hearing, especially the discussion among William A. Anders, representing the NASA Advisory Council, myself, and Subcommittee members, I was struck by what at times appeared to be the contradictory assertions that, on the one hand, the Space Shuttle should be viewed as a research and development vehicle for the duration of its operational life and that, on the other hand, NASA should move toward creation of an independent entity within NASA to manage Shuttle commercial operations since NASA's R&D centers were not well suited for this long-term operational responsibility. Given the importance of these roles and relationships for the future of the Space Transportation System, I thought it might be of help to the Subcommittee if I attempted to clarify this line of thinking. These are my personal views although I believe they reflect the general thinking of other Panel members.

In discussing continuing R&D as it relates to the Space Transportation System, several facts must be kept in mind:

1. Many of the original systems and equipment items--especially in the areas of general computers, avionics, and navigation--are obsolete and must be replaced or significantly upgraded.

2. Critical systems, such as the Space Shuttle main engines, the auxiliary power units, and the brakes, have performed below expectations and should be upgraded.

3. The complete flight envelope for the orbiter has not been defined as yet and its definition may indicate the need for structural or other changes to the orbiter.

4. The need for increased hardware reliability and reduced turnaround time is likely to dictate equipment and system improvements for many years to come.

5. A new generation of uppper stages, principally the Centaur and the IUS, must be incorporated in Shuttle operations if the full capability of the STS is to be realized.

These facts indicate clearly why a continuing program of R&D is essential to the safe and efficient operation of the Space Transportation System. In other words, there is no way NASA could responsibly "freeze" all design elements at the present stage of STS maturity. As a consequence, Shuttle operations are not likely to resemble those of a commerical airline in the near future. To assume such highly predictable routine operations is to ignore the important R&D tasks still underway and the uncertainties that inevitably are part of any R&D effort. We can realistically expect elements of this R&D program to continue into the 1990s.

The Shuttle can also provide a useful "test bed" to evaluate various advances in space and astronautics in much the same manner as industrial R&D will be carried on in Spacelab and other missions. For this reason the Panel's statement at the recent hearing noted: "...the Orbiter itself is the only vehicle capable of negotiating the complete velocity and heating encountered during STS missions. This knowledge would help resolve current problems and point up future technical directions. The high technology information which would become available through its use would also be applicable to advanced commercial and military vehicle design."

In short, an adjunct R&D program focused principally on upgrading the operational characteristics and reliability of the Space Shuttle is essential. This program in my view, can be directed most effectively by an entity within NASA charged exclusively with commerical operation of the Space Transportation System. Such an entity, discussed by William Anders and myself during the question and answer period, has been recommended by the Panel in our last two annual reports. NASA has taken several initial steps in this direction.

This operational entity must necessarily draw heavily upon the scientific and engineering expertise of the NASA R&D centers in much the same way that NASA uses outside contractors. However, the R&D agenda maintained by the operational entity would reflect those tasks related to improved operations, rather than the much wider agenda of innovations that could be supported by the R&D centers relatively free of the discipline of commercial operations. The perspective is one of fundamentally accepting the Space Transportation System as it presently exists, subject only to the improvements and changes discussed earlier in this letter.

As we noted in our testimony, even an R&D agenda focused on such operational priorities will be substantial and will require considerable funding support in the coming years. This R&D

program will move the STS steadily in the direction of greater reliability, greater cost effectiveness and enhanced safety. It will help bring to full operational maturity the world's first reusable space vehicle and set the stage for the next generation. This essential work, in my view, can be directed most effectively by an entity within NASA that has achievement of this operational maturity as its principal mission.

I hope these additional views are of assistance to the Subcommittee in its important review of the STS. If I or other members of the Panel can be of further help, please do not hesitate to all on us.

Sincerely,

John G. Stewart

John G. Stewart
Member, Aerospace Safety
Advisory Panel